NUCLEAR SCIENCE ABSTRACTS

Volume 26 Number 13

Abstracts 30619-33031

July 15, 1972

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Volume 26, Number 13, July 15, 1972

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A list of the journals scanned regularly and the abbreviations used appears in Issue 1 (January 15) of each volume of *Nuclear Science Abstracts* and is supplemented in Issues 7, 13, and 19. Issue 1 of each volume also describes the scope and arrangement of the subject matter covered in *Nuclear Science Abstracts.* The subject matter covered is also described in TID-4552, *Subject Scope of Nuclear Science Abstracts,* available free from the USAEC Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830. An outline of the subject categories appears in the Contents of each issue.

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

NEWCOMB, William A., Stability of a magnetic well, 25:1239
NEWKIRK, L. R., Superconductivity in the pseudobinary alloys V_3Si--Nb_3Al, 25:1093 (CALT-822-13)
NEWLAND, E. A., Radiation treatment of sewage, 25:140 (AAEC/LIB/Bib-254)

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

TRANSURANIUM ELEMENTS
- determination in bone ash, radiochemical method for, 25:40 (IDO-12073, pp 28-36)
- separation by ion exchange and complex-formation elution, 25:251(P)

TRIETHYLENETETRAMINE
- complexes with cobalt(III) and rhodium(III) chlorides, radiation effects on labeled, thermal-neutron, 25:137

TRITIUM
- content in Cattaraugus Creek near West Valley Processing Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
- content in Cattaraugus Creek near West Valley Processing Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
- determination in luminescent material by scintillation ccunting, 25:40 (IDO-12073, pp 28-36)

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. **Griffith, R. V.; Anderson, A. L.; Lindeken, C. L.** **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009-1). Dep. NTIS.

is indexed as:

CALIFORNIA UNIV., LIVERMORE. LAWRENCE RADIATION LAB.
Construction of a unique underground whole body counter, 25:372 (UCRL-72739)

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4270(Vol.2)	25-614	Dep. NTIS
4606	25-1530	Dep. NTIS
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Volume 26, Number 13, July 15, 1972

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 31000, 31034, and 31617.

30619 (NEIC-RR-44) NUCLEAR TECHNIQUE APPLICATIONS IN POLAND. Bibliography. Wezranowski, E.; Dancewicz, A. M.; Wezranowska, I. (Nuclear Energy Information Center, Warsaw (Poland)). 1971. 219p. Dep. NTIS (U. S. Sales Only).

More than 2000 references are presented in the following sections: analytical chemistry, radiation chemistry, properties and structure of metals and alloys, other solid materials, geophysics, geology and mineralogy, hydrology, meteorology, radiation sources, isotope and radiation application, power production, radiometric industrial applications, radiation processing industrial applications, tracer techniques, material testing, particle and radiation detectors, radiation detection and measuring instruments, other nuclear instrumentation, biology, genetic effects of radiation, biochemical effects of radiation, tracer studies in biochemistry and biology, somatic effects on animals, radiation effects on microorganisms and plants, plant nutrition, animal production and health, pest control in agriculture, food protection and preservation, forestry, medicine, tracer studies in medicine, radiation effects on man, and toxicology and decontamination. An author index is included. (M.C.G.)

30620 (ORO-671-1) PROCEDURES FOR HANDLING AND ANALYSIS OF URANIUM HEXAFLUORIDE. VOLUME 1. INSPECTION, WEIGHING, AND SAMPLING OF URANIUM HEXAFLUORIDE CYLINDERS. (Oak Ridge Operations Office (AEC), Tenn.). Apr 1972. 40p. Dep. NTIS.

Procedures for cylinder inspection, weighing, and sampling are presented. These procedures are typical of those currently in use at AEC-owned gaseous diffusion plants. (M.C.G.)

30621 (ORO-671-2) PROCEDURES FOR HANDLING AND ANALYSIS OF URANIUM HEXAFLUORIDE. VOLUME 2. ANALYSIS. (Oak Ridge Operations Office (AEC), Tenn.). Apr 1972. 196p. Dep. NTIS.

Analytical procedures that may be used by AEC customers and UF_6 processors to determine conformance to the Federal Register specifications and other properties for UF_6 are given. They are typical of those currently in use at AEC-owned gaseous diffusion plants. Methods described include: subsampling; gravimetric determination of uranium; isotopic analysis; determination of hydrocarbons and halocarbons; atomic absorption determination of Sb; colorimetric determination of Br, titrimetric determination of Cl; colorimetric determination of Si and P; spectrographic determination of B and Si; atomic absorption determination of Ru; spectrographic determination of Ru; colorimetric determination of Ti and V; spectrographic determination of metallic impurities; determination of Hf, Mo, Nb, Ta, Ti, W, and Zr; colorimetric determination of W; colorimetric determination of Th; spectrographic determination of Th and rare earths; colorimetric determination of Mo; atomic absorption determination of metallic impurities; determination of boron-equivalent neutron cross section; determination of ^{233}U, ^{232}U, fission product activity, and alpha activity of Pu; and determination of Np. (M.C.G.)

30622 STATISTICAL AND MATHEMATICAL METHODS IN ANALYTICAL CHEMISTRY. Currie, L. A.; Filliben, J. J.; DeVoe, J. R. (National Bureau of Standards, Washington, D. C.). Anal. Chem.; 44: No. 5, 497R-512R(Apr 1972).

The period October 1967 to October 1971 is covered by the review. Topics covered include: characterization of the measurement process, planning and control of experiments, curve fitting, on-line computers, and other techniques. (571 references) (M.C.G.)

30623 ORGANIC ELEMENTAL ANALYSIS. Ma, T. S. (City Univ. of New York, Brooklyn); Gutterson, Milton. Anal. Chem.; 44: No. 5, 445R-57R(Apr 1972).

Recent developments in quantitative analysis of the elements in organic compounds for the period October 1969 to October 1971 are reviewed. Topics covered include: determination of C, H, N, O, halogens, S, Se, Te, P, As; analysis of organometallics; submilligram samples; and trace analysis. (253 references) (M.C.G.)

30624 KINETIC ASPECTS OF ANALYTICAL CHEMISTRY. Greinke, Ronald A. (Union Carbide Corp., Parma, Ohio); Mark, Harry B. Jr. Anal. Chem.; 44: No. 5, 295R-300R(Apr 1972).

The literature from February 1970 through December 1971 is reviewed and classified according to catalyzed reaction methods, uncatalyzed reaction methods, differential reaction rate methods (for mixtures), and instrumented advances. (120 references) (M.C.G.)

30625 ION EXCHANGE. Walton, Harold F. (Univ. of Colorado, Boulder). Anal. Chem.; 44: No. 5, 256R-70R(Apr 1972).

Developments in ion exchange studies are reviewed. Column theory, equilibrium, kinetics, exchanger properties, techniques, new and special exchangers, inorganic applications, nonchromatographic uses, organic and biochemical applications, and distribution and separation studies of many elements are discussed. (566 references) (M.C.G.)

30626 GAS CHROMATOGRAPHY. Cram, Stuart P. (Univ. of Florida, Gainesville); Juvet, Richard S. Jr. Anal. Chem.; 44: No. 5, 213R-41R(Apr 1972).

Developments in the field of gas chromatography in 1970-71 are reviewed. Topics covered include: packed columns, open tubular columns, and identification and analysis. (1034 references) (M.C.G.)

30627 ELECTRON SPIN RESONANCE. Janzen, Edward G. (Univ. of Georgia, Athens). Anal. Chem.; 44: No. 5, 113R-21R(Apr 1972).

Quantitative applications of ESR or rates and equilibria of systems of possible interest to analytical chemists are reviewed. Topics covered include: direct determinations of transition metal ions by ESR, use of ESR to detect titration end points, use of ESR in studying dynamic systems, oscillating Mn(II) concentration, cobalt-oxygen complexes, and transition metal complexes. (48 references) (M.C.G.)

30628 CHROMATOGRAPHY. Zweig, Gunter (Syracuse Univ. Research Corp., N. Y.); Sherma, Joseph. Anal. Chem.; 44: No. 5, 42R-79R(Apr 1972).

The literature of liquid column, paper, and thin-layer chromatography abstracted in Chemical Abstracts in the period between mid-December 1969 and December 20, 1971 is reviewed. Topics covered include: general considerations and theory, column adsorption and partition chromatography, column gel chromatography, paper chromatography, and thin-layer chromatography. (1636 references) (M.C.G.)

30629 BIOCHEMICAL ANALYSIS. Schwartz, Morton K. (Sloan-Kettering Inst. for Cancer Research, New York). Anal. Chem.; 44: No. 5, 9R-32R(Apr 1972).

Developments in the area of biochemical analysis during the period from January 1968 through December 1971 are covered. Routine applications and minor modifications of accepted techniques or methods are excluded. Topics covered include: centrifugation, dialysis, and filtration; electrophoresis; isoelectric focusing; thin-layer chromatography; gas chromatography; absorbent techniques; electrochemical methods; radio and radioimmuno assay; activation analysis; spectral and electron probe analysis; mass spectrometry, magnetic resonance, lasers; atomic absorption; spectrophotometry, colorimetry; and bioluminescence and fluorescence. (1075 references) (M.C.G.)

30630 METODY POLNOGO KHIMICHESKOGO ANALIZA SLOZHNYKH REDKOMETAL'NYKH MINERALOV. (Methods of Complete Chemical Analysis of Complex Minerals Containing Rare Metals). Saltykova, V. S.; Kukharchik, M. V.; Kapitonova, T. A.; Kataeva, Z. T.; Razina, I. S. Moscow; Izdatel'stvo Nauka (1972). 88p.

Schemes for total chemical analysis by wet methods are described for minerals containing such elements as Nb, Ti, Zr, rare earths, barium, and boron. A number of minerals (monazite, xenotime, obruchevite) contain a few percent of U or Th, and the separation and analytical schemes given are accordingly designed to handle these radioactive elements. (K.S.W.)

Activation and Nuclear Reaction Procedures

Refer also to abstracts 30845, 31032, 31147, and 31389.

30631 (CONF-720413-1) ENVIRONMENTAL POLLUTION: USE OF NEUTRON ACTIVATION ANALYSIS TO DETERMINE THE FATE OF TRACE ELEMENTS FROM FOSSIL FUEL COMBUSTION IN THE ECOLOGICAL CYCLE. Lyon, W. S.; Bate, L. C.; Emery, J. F. (Oak Ridge National Lab., Tenn.). [1971]. Contract W-7405-eng-26. 14p. Dep. NTIS.

From Symposium on nuclear activation techniques in the life sciences; Ljubljana, Yugoslavia (10 Apr 1972).

A program has begun at ORNL to study the trace element profile through a coal-fired steam plant. In cooperation with the Tennessee Valley Authority (TVA) we have sampled coal and air entering a TVA steam plant and all the wastes and emissions from the combustion of the coal were sampled. These samples are being analyzed by neutron activation analysis (NAA) both nondestructively and by dissolution and chemical separation of certain elements. In addition some samples have been analyzed by spark source mass spectrometry (SSM) and these results compared with those from NAA. Flameless atomic absorption has been used to determine mercury in many of these samples and comparison with NAA indicates excellent agreement; this latter point is further substantiated by results obtained from determination of Hg in a series of U. S. Bureau of Mines round-robin coal samples. The data from these studies have importance in the overall study of trace elements in all living systems since most of the effluent material from these steam plants finds its way back into the ecological cycle through one path or another. Neutron activation analysis thus provides important information in assisting governmental agencies to plan for proper control and disposal of such waste materials. (auth)

30632 (DP-674) ASSAY OF LITHIUM-ALUMINUM BILLETS BY NEUTRON ABSORPTION. Herold, T. Richard (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan 1962. Contract AT(07-2)-1. 11p. Dep. NTIS.

Declassified 27 Oct 1971.

An instrument was developed for assaying the lithium content of solid lithium-aluminum billets that contain between 1 and 5% lithium by weight. A neutron absorption technique is used. Billets approximately 8 inches in diameter, 24 inches long, and weighing about 100 pounds can be assayed in 15 minutes to within an accuracy of ±0.8 wt %. (auth)

30633 (NP-19261) DETERMINATION OF TOXIC TRACE ELEMENTS IN WATER BY MEANS OF ^{252}Cf NEUTRON ACTIVATION. Fanger, U. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Dec 1971. 24p. (In German). Dep. NTIS (U. S. Sales Only).

Taking a simple model for quasi-continuous supervision of flowing water, the possibility is investigated to detect toxic traces of As, Cd, Cr, Cu, Hg, Pb, Se, Zn, and F by means of activation analysis with ^{252}Cf neutrons. The well-known data for capture cross sections and radioactive decay and for the special flux distribution of ^{252}Cf neutrons in water was taken as a basis for calculation. The results demonstrate clearly that the method is not sensitive enough to detect these elements in the ppB to ppM region within a reasonably short time and with sufficient precision, unless more sophisticated techniques are applied. (auth)

30634 THRESHOLD SENSITIVITIES IN THE NEUTRON ACTIVATION ANALYSIS OF FLOWING SOLUTIONS. Kartashev, E. R.; Shtan, A. S. Tr. Vses. Nauch.-Issled. Inst. Radiats. Tekh.; No. 5, 117-19(1971). (In Russian).

Threshold sensitivities for determination of various elements in a flowing solution were calculated for irradiation with thermal or fast neutrons from isotopic sources and with 14-MeV neutrons from generators with an output of $\simeq 5 \times 10^8$ neutrons per sec. Limits of detection (mg per liter) for In, V, Mn, Se, Al, and F are 0.2, 60, 3.5, 84, 600, and 1060, respectively, with use of an irradiation unit with a ^{239}Pu–Be source (neutron output $\simeq 5 \times 10^6$ neutrons/sec), a measuring unit with a NaI(Tl) detector (80 mm × 80mm), and a recording unit. (Referativnyi Zh.)

30635 RECENT APPLICATIONS OF NEUTRON ACTIVATION ANALYSIS IN MEDICINE AND BIOLOGY. Travesi, A. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid); 16: No. 75, 27-38(Jan-Feb 1972). (In Spanish).

An introduction to the method of analysis by neutron activation is presented; fundamentals and most outstanding characteristics are discussed. The significance and possibilities of this method in the current practice of medicine are described. The characteristics of the most important elements of biological systems are also indicated. Applications of stable tracers in biological analysis are also pointed out. Finally, there is an extensive exposition of the techniques and applications of activation analysis in vivo. (tr-auth)

30636 NEUTRON ACTIVATION ANALYSIS OF MICROTOME CUTS IN EXAMINATION OF PAPER FOR ITS FILLER DISTRIBUTION. Kuusi, J.; Lehtinen, A. (Univ. of Helsinki, Otaniemi, Finland). Pulp Pap. Mag. Can.; 71: No. 3, 37-43(1970).

The sample of paper is divided through its thickness into 10 to 12 sections by use of a microtome. Each section (0.1 to 0.4 mg) is irradiated for $\simeq$8 minutes in a thermal neutron flux. Several important constituent elements (^{27}Al, ^{50}Ti, ^{48}Ca, ^{26}Mg, and ^{138}Ba) of the commonly used paper fillers, e.g., china clay, titanium dioxide, or calcium carbonate, undergo (n,γ) reactions giving short-lived isotopes (^{28}Al, ^{51}Ti, ^{49}Ca, ^{27}Mg, and ^{139}Ba, respectively). The γ ray intensities are measured a few minutes after irradiation; Al should be determined after 2 to 4 minutes waiting time, with 1 minute measurement time. The standard deviation of repeated analyses is $\simeq \pm 5\%$. Interference by long-lived radionuclides (^{24}Na, ^{56}Mn, and ^{38}Cl) is small because of the short irradiation period. Interference by the reaction ^{27}Al(n,p)^{27}Mg prevents determination of Mg in samples also containing Al. The probability of the reaction ^{28}Si(n,p)^{28}Al is small, so that there is no interference with the determination of Al in china clay. Examples are given of the distribution of the fillers through the thickness of paper samples. Integration of the filler distributions gives total contents for Al and Ti 10 to 20% lower than those from direct determinations on the uncut paper. (Anal. Abstr.)

30637 YIELDS OF PHOTONUCLEAR REACTIONS FOR PHOTON-ACTIVATION ANALYSIS WITH HIGH-ENERGY BREMSSTRAHLUNG Kato, Toyoaki; Oka, Yoshinaga (Tohoku Univ., Sendai). Talanta; 19: No. 4, 515-25(Apr 1972).

Experimental reaction yields were determined for various types of photonuclear reactions, induced in 52 elements by means of Bremsstrahlung irradiation with maximum energies ranging from 30 to 72 MeV, and of detection of the resultant activities with a lithium-drifted germanium detector. From the results obtained, sensitivities in photon-activation analysis were evaluated and the reactivity of high-energy photons with nuclei in a wide range of atomic number is discussed. Some nuclear considerations in photon-activation analysis, involving the relative probability of forming each product as a result of the (γ,xnyp) reactions are also given. (auth)

30638 SOLUBILIZATION OF ^{233}Pa FORMED IN URANIUM MINERALS IRRADIATED WITH NEUTRONS. Dominguez, G.; Bautista, E. R. (Junta de Energia Nuclear, Madrid). An. Quim.; 67: No. 3, 281-7(1971). (In Spanish).

Activation analysis for Th by means of ^{233}Pa requires separation of the latter from the irradiated sample. This can be achieved by dissolution, with heating, in H_2SO_4–HF or, preferably, HNO_3–HF–H_2SO_4. Recovery is $\simeq$95% with the mixture containing HNO_3. (Anal. Abstr.)

30639 NOTE ON DETERMINING PROTEIN CONTENTS IN VARIOUS WHEAT FLOURS AND FLOUR STREAMS BY THE

KJELDAHL AND BY NEUTRON-ACTIVATION METHODS. Tsen, C. C. (Kansas State Univ., Manhattan); Martin, E. E. Cereal Chem.; 48: No. 6, 721-6(Nov-Dec 1971).

A study was made to determine whether flour samples obtained from different wheat varieties, types, and various flour streams of different particle sizes and characteristics have any effect on the precision of the neutron activation method, as compared with the Kjeldahl method. The two methods agreed well and none of the variables considered appeared to have any effect. (M.C.G.)

30640 GAMMA ACTIVATION DETERMINATION OF FLUORINE IN FLUORITE ORE. Azimov, S. A.; Miller, R. A.; Khakimov, M. Nauch. Tr., Tashkent. Gos. Univ.; No. 388, 92-6 (1970). (In Russian).

The method is based on the reaction $^{19}F(\gamma,n)^{18}F$ (threshold energy 10.4 MeV). The sample and NaF standard, which have been compressed into tablets, are irradiated in a betatron with γ-bremsstrahlung (maximum energy 25 MeV; dose capacity 8000 roentgens per min); after completion of irradiation the intensity of the γ emission of ^{18}F in sample and standard are measured on a γ–γ coincidence scintillation spectrometer. The error is <1%. Up to 200 samples can be analyzed in a working day. (Referativnyi Zh.)

30641 DETERMINATION OF OXYGEN AND CARBON IN TUNGSTEN. Azimov, S. A.; Miller, R. A.; Khakimov, M. Nauch. Tr., Tashkent. Gos. Univ.; No. 388, 104-13(1970). (In Russian).

The method is based on the reactions $^{12}C(\gamma,n)^{11}C$ and $^{16}O(\gamma,n)^{15}O$ (threshold energies 18.7 and 15.6 MeV, respectively). To determine C, the sample powder and $CaCO_3$ standard are compressed and irradiated as described for F in fluorite (Analyt. Abstr., 1971, 21, 3268). Fifteen minutes after the end of irradiation, the annihilation γ radiation of ^{11}C is measured with use of a γ–γ coincidence spectrometer. The sensitivity is 0.01% for C and the error is <5%; >0.05% of Mo interferes. For the simultaneous determination of O and C, the method is similar, but the annihilation γ radiation at 0.511 MeV is measured, decay curves are constructed and the individual activities of ^{15}O and ^{11}C are calculated by the method of least squares or by the use of nomograms. The sensitivity of the determination of C and O is 0.01%; >0.003% of P and >0.05% of Mo interfere. About 100 samples can be analyzed in a working day. (Referativnyi Zh.)

30642 DETERMINATION OF NITROGEN IN LIVING PATIENTS. Biggin, H. C.; Chen, N. S.; Ettinger, K. V.; (and others) (Univ. of Birmingham, Eng.). Nature (London) New Biol.; 236: No. 67, 187-8(12 Apr 1972).

Neutrons produced by bombarding a Li target with 10-MeV protons from the 1.5-m Nuffield cyclotron were used in an activation analysis study of whole-body N, and in the detection of trace amounts of Cd. Tissue-equivalent liquid phantoms were used to study a technique for making in vivo measurements by counting during irradiation. Nitrogen content was measured by monitoring the 10.8-MeV γ rays resulting from thermal neutron capture. The problems of large volume detectors and background radiation and scattering are briefly discussed in relation to neutron collimation, pulsing the beam, and shielding of the detectors. It was estimated that for a man of 70 kg weight, using 2 detectors, 16,000 counts would be expected for a dose of 0.1 rem, with a statistical accuracy of 1.5%, allowing for background contribution to error. In the Cd studies Ge(Li) detectors were used, because the most prominent peak in the capture γ spectrum was the 0.559-MeV peak. Some typical spectra obtained are presented and data showed that for 9 g of Cd in 7l solution, 30,000 counts were obtained for a dose of 1 rem. The detection limit was estimated as 30 mg of Cd in a volume of 7l, using 2 detectors (99.73% of confidence level). (UK)

30643 GAMMA-ACTIVATION DETERMINATION OF INDIUM IN A STUDY OF COPRECIPITATION PROCESSES. Azimov, S. A.; Miller, R. A.; Khakimov, M. Nauch. Tr., Tashkent. Gos. Univ.; No. 388, 121-5(1970). (In Russian).

A method is described for determining In in the precipitate obtained in a study of the co-precipitation of In with $Al(OH)_3$. The sample and a standard (a mixture of the hydroxides of Al and In of known composition) are irradiated with γ rays (maximum energy 25 MeV) from a betatron at a dose rate of 800 roentgens per min, then set aside for 5 to 10 min. The activity of ^{112}In is then measured at the 95-keV γ peak with use of a single-channel γ spectrometer. The sensitivity is 0.01% of In, and the error is <3%. (Referativnyi Zh.)

30644 APPLICATIONS OF ACTIVATION ANALYSIS: MODERN TRENDS IN CRIME DETECTION, POLLUTION STUDIES, AND MEDICINE. Krishnan, S. S. (Indian Inst. of Tech., Madras). pp 63-70 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

Forensic analyses of hair, uses of activation analysis in studies on shooting cases, analyses of paint and glass, toxicological applications of activation analysis, and other uses of this tool are discussed. (M.C.G.)

30645 ESTIMATION OF FISSILE ISOTOPES USING Ge(Li) DETECTOR. Prakash, Setya; Manohar, S. B.; Ramaswami, A.; (and others) (Bhabha Atomic Research Centre, Trombay, India). 79-86 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2.).

The study of γ spectra of fission products with the help of high-resolution Ge(Li) detectors can be used for estimation of fissile materials in a mixture or in a pure sample. Limitations and possible improvements are discussed. Results obtained using pure ^{235}U and ^{239}Pu and mixtures of ^{235}U and ^{239}Pu are shown. In the estimation of pure samples the accuracy is about 2%, while that in a mixture is 5 to 10%. (M.C.G.)

30646 NEUTRON ACTIVATION ANALYSIS OF MINERAL NUTRIENTS IN WHEAT LEAVES. Tejam, B. M.; Iyer, K. Shankar; Doctor, Z. K.; Haldar, B. C. (Inst. of Science, Bombay). pp 283-9 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

Neutron activation analysis of Mn, Zn, Mo, Ca, P, S, Na, and K in wheat leaves is reported. Samples of finely powdered wheat leaves dried at 80°C and microgram amounts of standards of each element to be determined were irradiated in sealed silica tubes at a thermal neutron flux of 2 to 5×10^{12} n/cm^2/ sec for a period of 20 to 24 hrs. The irradiated sample was dissolved in a mixture of HNO_3 + HCl in the presence of carriers and subjected to radiochemical purifications involving selective extraction and precipitation of the desired element. The purified samples were counted on a suitable counter or on a gamma spectrometer. The results of analysis of two samples are given. (auth)

30647 ESTIMATION OF SEED PROTEIN CONTENT BY FAST NEUTRON ACTIVATION ANALYSIS. Misra, S. C.; Rao, U. S.; Gupta, U. C.; Bhatia, C. R. (Bhabha Atomic Research Centre, Trombay, India). pp 291-5 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-70114See CONF-701148–(Vol.2).

The procedure of estimating protein content in the seeds of important crop plants by fast neutron activation of nitrogen using a (d,t) generator was developed and standardized. Calibration curves were obtained by irradiating a set of reference samples containing various amounts of nitrogen together with monitors under well-defined and reproducible geometrical conditions and plotting the ratio of the activities for each sample-monitor pair against the concentration of nitrogen in the sample. The results obtained by activation method agree very well with those obtained by the Kjeldahal analysis. During neutron irradiation the seeds receive a dose of about 1.25 rad. (auth)

30648 LIQUID–LIQUID EXTRACTION BEHAVIOUR OF MERCURY(II) AS CHLORIDE, BROMIDE, IODIDE, AND THIOCYANATE. Tandon, S. N.; Gupta, C. B. (Univ. of Roorkee, India). pp 311-16 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

A detailed study of the liquid–liquid extraction behavior of Hg(II) halo and thiocyanate complexes was needed for radiochemical separations involving mercury. The distribution ratios were determined in different oxygenated and nonoxygenated solvents using ^{203}Hg as tracer. The effects of molarity of acids, their salts, concentration of Hg(II) ions, temperature, and presence of different anions on distribution ratio were investigated. For such extractions oxygenated solvents were better solvents than nonoxygenated ones. There was a temperature effect in the case of bromide and iodide. There was no effect of the variation in the concentration of Hg(II) ions. The effects of NO_3^-, $C_2O_4^{2-}$, $C_4H_4O_6^{2-}$, $C_6H_5O_7^{3-}$, and EDTA on the distribution ratios were also studied. Using these studies the possibility of separation of Hg(II) from Au(III) and Tl(III) are being investigated. (auth)

30649 MICROANALYSIS OF NITROGEN BY MEANS OF THE DIRECT OBSERVATION OF NUCLEAR REACTIONS APPLICATIONS. Amsel, G.; David, D. (Ecole Normale Superieure, Paris). pp 243-58 of Properties and Use of MIS Structures.

/Borel, Joseph (ed.). Grenoble, France; Centre d'Etudes Nucleaires (1969).

From Conference on properties and use of MIS structures; Grenoble, France (17 Jun 1969).

Microanalysis by the direct observation of nuclear reactions was applied to the determination of nitrogen-14. The energy spectrum corresponding to this isotope, when bombarded with deuterons, was studied at various energies. The peak from the reaction $^{14}N(d,\alpha)^{12}C$, at an energy of about 10 MeV, is well isolated and allows the determination of nitrogen in the presence of most of the other nuclei. Other peaks of the spectrum may be used when isotopes such as ^{10}B or ^{19}F are not present in the sample; counting rates may then be higher. The sensitivity of this nondestructive analytical method is of the order of 10^{-3} μg/cm^2. Using tantalum nitride as a standard, an absolute measurement of the amount of nitrogen is obtained. The application of these techniques to the study of reactive sputtering showed the influence of nitrogen partial pressure on the composition of the nitride films formed. Other applications to the study of the nitration of various metals in hot ammonia, and to the study of anodic oxidation, are also described. (France)

30650 STUDY OF OXYGEN SELF DIFFUSION IN THERMAL AND ANODIC SILICA. Croset, M.; Rigo, S.; Amsel, G. (Societe Europeenne des Semi-Conducteurs et Microelectroniques, Orsay, France. Ecole Normale Superieure, Paris). pp 259-68 of Properties and Use of MIS Structures. /Borel, Joseph (ed.). Grenoble, France; Centre d'Etudes Nucleaires (1969).

From Conference on properties and use of MIS structures; Grenoble, France (17 Jun 1969).

The electric properties of MIS structures have been extensively studied during recent years. These properties are compared with the physicochemical behavior of dielectric films and their interfaces. The growth mechanisms of commonly used dielectrics are analyzed. Their behavior under accelerated aging stresses is studied. The aging processes being chosen are the most effective on the electric properties of MIS structures. The dielectric films and their chemical stability are analyzed by direct measurement of their oxygen and nitrogen content using microanalysis by direct observation of nuclear reactions. Only results on oxides are presented. (France)

30651 NUCLEONICS. Lyon, W. S.; Ricci, E.; Ross, H. H. (Oak Ridge National Lab., Tenn.). Anal. Chem.; 44: No. 5, 438R-45R(Apr 1972).

Developments during the past two years are reviewed. Topics covered include: absolute measurement and standardization, measurement improvements, liquid scintillation counting, radiochemical separations and analytical procedures utilizing radioisotope techniques, and activation analysis. (186 references) (M.C.G.)

30652 NON-DESTRUCTIVE DETERMINATION OF HAFNIUM IN ZIRCONIUM BY Be-D NEUTRON ACTIVATION ANALYSIS USING SELENIUM AS INTERNAL STANDARD. Jinno, Kiyokatsu; Katayama, Kozo; Ishii, Daido (Nagoya Univ., Japan). Nippon Kagaku Kaishi; No. 1, 78-81(Jan 1972). (In Japanese).

A rapid and nondestructive method is required for the determination of hafnium contents in zirconium. A fast neutron activation method based on the measurement of the short half-life isotope ^{179m}Hf produced by the $^{179}Hf(n,n')^{179m}Hf$ reaction was investigated. The use of Be-D neutrons made it possible to avoid the interferences from oxygen, zirconium, and other elements. Selenium was used as an internal standard material for assuring the precision of the analytical results. (auth)

30653 ACTIVATION ANALYSIS OF NAIL CLIPPINGS. Maeda, Hisato (Mie Prefectural Univ., Tsu, Japan). Radioisotopes (Tokyo); 21: No. 3, 170-5(Mar 1972). (In Japanese).

Analytical procedures for nails using neutron activation analysis were established. Nail and standard samples were irradiated in KUR (Kyoto University Reactor) at a flux of 2.75 × 10^{13} thermal neutrons/cm^2/sec and irradiation time was 60 minutes. After irradiation, nail samples were analyzed by nondestructive and destructive methods, and sodium, manganese, and copper contents in nail samples were obtained. Manganese and copper were adequately separated by using ion-exchange column (Dowex I × 8) from sodium, which was the most interfering element when activation analyses of biologic specimens were tried. Mean sodium, manganese, and copper values in 8 nail samples obtained from nondestructive methods were, respectively, 6.47 × 10^2 Naμg/g, 1.42 Mnμg/g 6.72 × 10^2 Naμg/g, and mean manganese and copper values obtained from destructive methods were 1.30 Mnμg/g and 2.19 × 10^1 Cuμg/g. A mean of each ratio of sodium values in 8 nail samples obtained from nondestructive measurements to its values measured after heating and dissolving was 1.13 times and the standard deviation was ±0.10. Those of manganese and copper values in 8 nail samples obtained from nondestructive methods to destructive methods were respectively 1.00 and 1.42 times with standard deviations of ±0.11 and ±0.43. The mean percentage of yields of manganese and copper were 99.6 and 90.1%. (auth)

30654 PLATINUM AND GOLD IN CHONDRITIC METEORITES. Ehmann, W. D.; Gillum, D. E. (Univ. of Kentucky, Lexington). Contract AT(40-1)-2670. Chem. Geol.; 9: No. 1, 1-11(Mar 1972).

Platinum and gold were determined simultaneously in 43 chondrites by neutron activation analysis. A rapid radiochemical procedure employing a substoichiometric separation of gold was used. Platinum was determined by counting the 0.159-MeV gamma rays of ^{199}Au (the radioactive daughter of ^{199}Pt) and gold was determined by counting the 0.412-MeV gamma rays of ^{198}Au. The atomic abundances relative to Si = 10^6 atoms for the C1/C2/C3 carbonaceous chondrites are 1.34/1.07/1.43 for platinum and 0.19/0.20/0.18 for gold, respectively. The L- and LL-group chondrites were uniformly depleted in platinum and gold with respect to the carbonaceous chondrites while the H-group chondrites exhibited abundances similar to the carbonaceous chondrites. The enstatite chondrites were enriched in gold but had platinum abundances similar to those in the carbonaceous chondrites suggesting a fractionation among the noble metals in their formation. Platinum and gold were positively correlated within each major chondrite group and yielded a correlation coefficient of 0.70 that is significant at the 99.9% confidence level. (auth)

30655 ACTIVATION ANALYSIS OF AIRBORNE DUST. II. Mamuro, Tetsuo; Matsuda, Yatsuka; Mizohata, Akira; Matsunami, Tadao (Radiation Center of Osaka Prefecture, Sakai, Japan). Radioisotopes (Tokyo); 21: No. 3, 164-9(Mar 1972). (In Japanese).

Instrumental neutron activation analysis by γ spectrometry with a high-resolution and large-volume Ge(Li) detector followed by automatic data analysis with an electronic computer was applied to elemental analysis of airborne dust samples, which were collected at four stations selected in Osaka and Sakai cities. Monthly average concentrations of various elements were determined during the period from March 1970 to March 1971. For most elements, the highest concentration appeared in November to December and the lowest in August. A somewhat lower peak concentration appeared around June. Such a seasonal variation can be ascribed mainly to the meteorological conditions in Osaka district. Variation was observed for several elements such as Zn, As, Se, Sb, and Th, and was presumed to be closely related to industrial activities. Conspicuous area dependency was found, especially for concentrations of Se, As, Ba, La, and Th. (auth)

30656 ACTIVATION ANALYSIS WITH 14 MeV GENERATORS. Wood, D. E. (Kaman Sciences Corp., Colorado Springs, Colo.). Advan. Activ. Anal.; 2: 265-337(1972).

The development of high yield sources of 14-MeV neutrons has stimulated interest in fast neutron activation analysis during recent years, and the technique has the potential for many more routine industrial analyses as the equipment becomes reliable and rugged enough for plant use. Radiation problems and examples of laboratory and industrial systems for various purposes are discussed. The review is presented under the following main headings; accelerator design principles (including sealed tube neutron generators); irradiation methods and neutron flux monitoring; instrumentation; calibration standards precision and accuracy; radiation problems; laboratory systems; and special purpose systems. (UK)

30657 CHARGED PARTICLE ACTIVATION ANALYSIS. Ricci, Enzo (Oak Ridge National Lab., Tenn.). Advan. Activ. Anal.; 2: 221-63(1972).

It is stated that although the charged particle technique is based on the same general principles as other activation analysis methods, it diverges significantly from them, both in theory and experiment, and has special problems, but at the same time interesting possibilities. After a brief historical introduction and a discussion of the characteristics of particle accelerators relevant to the analyst, the mathematical basis of the technique is described in detail. New experimental advances are then described, and future trends indicated. The most used charged particle analytical method at present in use is probably ^3He activation. Because many reactions of ^3He particles with light elements are exoergic, and because their Coulomb barriers for these elements are relatively small, the ^3He kinetic energies required are low, resulting in little matrix interference and implying a lower investment in particle accelerators. Among drawbacks charged particle bombardment often yields positron-emitting nuclides, resulting in counting interference; also, the short range of these particles in most samples restricts analysis to their surface. The charged particle method is most sensitive for traces of light elements. Main headings of the review are as follows: Charged particle accelerators (Van de Graaff machines; cyclotrons); theory of the technique; experimental procedure; present and future trends. (UK)

30658 APPLICATIONS OF ACTIVATION ANALYSIS TO GEOCHEMICAL, METEORITIC, AND LUNAR STUDIES. Showalter, D. L.; Schmitt, R. A. (Oregon State Univ., Corvallis). Advan. Activ. Anal.; 2: 185-219(1972).

It is stated that the need for accurate abundance data, and for the capability of analyzing very small samples without loss of sensitivity, has made activation analysis a very important geochemical tool. A review is presented on the following topics: geochemical studies of terrestrial rocks and ores (elemental determinations by instrumental fast neutron activation analysis, and by instrumental thermal neutron activation analysis, photonuclear activation analysis, charged particle activation analysis and radiochemical neutron activation analysis; solid-liquid partition coefficient measurements in lavas; autoradiography studies; $\gamma-\gamma$ coincidence counting; age determinations by neutron activation); and meteoritic studies, tektite studies and lunar studies by the foregoing methods. (UK)

30659 ACTIVATION ANALYSIS APPLICATIONS IN ART AND ARCHAEOLOGY. Sayre, Edward V. (Brookhaven National Lab., Upton, N. Y.). Advan. Activ. Anal.; 2: 155-84(1972).

A review is presented under the following headings: special advantages of activation methods for the study of art and archaeological materials; analytical methods (activation; counting; standardization and flux monitoring); compositional studies of works of art and archaeological artifacts (pottery; glass, obsidian and stone; coins and other metal objects; organic materials; pigments from painting); structural studies by means of activation autoradiography (autoradiographs of oil paintings; regeneration of faded photographs). (UK)

30660 CONTROL OF ERRORS IN ACTIVATION ANALYSIS. Lukens, H. R. (Gulf General Atomic Inc., San Diego, Calif.). Advan. Activ. Anal.; 2: 127-54(1972).

The sources of errors in activation analysis as currently understood are reviewed, without to any extent going over ground previously covered in other comprehensive reviews. Most of the sources of error are well understood and measures have been developed to deal with them, and as a consequence the accuracy and precision of carefully performed analyses may be limited only by the statistics of radioactivity measurements. The discussion presented is based largely on planning the analytical procedure. Problems associated with analysis using a nuclear reactor are emphasized, but problems associated with accelerator activation are not ignored. Main headings are as follows: considerations concerning the sample; self shielding; sample containers; use of comparator standards; activation considerations; radiochemical separations; radioactivity measurements; data reduction. (UK)

30661 NEUTRON ACTIVATION ANALYSIS IN PROCESS CONTROL. Berry, Peter F.; Martin, Troy C. (Nuclear-Chicago Corp., Austin, Tex.). Advan. Activ. Anal.; 2: 89-125 (1972).

A review is presented on the techniques of activation analysis as they apply to industrial process control, and some examples are discussed. Related techniques utilizing analysis of prompt γ-radiation from fast neutron inelastic scattering and thermal neutron capture are also considered, interest in which has increased with improved γ-ray detection systems. Headings are as follows: Methods and instrumentation (neutron sources; sample presentation schemes; detection systems; data acquisition and processing); applications (O, N, F, Al, Si, Ca, bulk materials). (UK)

30662 PHOTON ACTIVATION ANALYSIS. Engelmann, C. (CEN, Saclay, France). Advan. Activ. Anal.; 2: 1-55(1972).

Photon activation analysis is complementary to neutron and charged particle activation analysis and gives good sensitivity and specificity for some elements. In comparison with neutron activation analysis it has the advantage of giving high sensitivity for determination of the light elements C, N and O, and in comparison with charged particle analysis it is sometimes preferable since it avoids the possibility of interference from neighboring elements, and activation of the sample is relatively uniform and not confined to a layer of thickness limited by the penetrating power of the activating particles. A review is presented under the following main headings: introduction; analytical possibilities with photon activation; sources of photons for activation analysis; bremsstrahlung radiation; typical irradiation facilities; analytical sensitivity and significance of interfering reactions; practical applications of activation analysis by (γ,n) reactions. (UK)

30663 ACTIVATION ANALYSIS OF MERCURY IN ENVIRONMENTAL STUDIES. Westermark, Torbjoern (Royal Inst. of Tech., Stockholm); Sjoestrand, Bernt. Advan. Activ. Anal.; 2: 57-88(1972).

It is stated that neutron activation analysis of Hg involves difficult problems, but is nevertheless a well-established procedure applicable to almost all kinds of samples, and is particularly useful in environmental and toxicological studies. A review is presented under the following headings: Methods of activation analysis of Hg (principles; complications; precision, accuracy and sensitivity; applicability); applications (mineral kingdom; plant kingdom; animal kingdom); industrial and other human activities giving rise to Hg in the environment; limitations as to chemical state; comparison with other methods; link with ecology; problems to be solved. (UK)

30664 NEUTRON ACTIVATION ANALYSIS OF CALCIUM IN BIOLOGICAL SAMPLES. Weber, David A.; Andrews, Howard L. (Univ. of Rochester, N. Y.). J. Nucl. Med.; 13: No. 5, 293-9(May 1972). (UR-49-1400).

The use of thermal neutron activation for determining the calcium content at selected anatomic sites in man is reported. Relatively low thermal neutron fluences were used to assay calcium content in mice and human cadaver fingers. Activation products were detected and identified by γ counting, using NaI(Tl) and Ge(Li) detectors. Amounts of Na, Cl, Mn, and Mg present were also determined. (M.C.G.)

30665 PHYSICAL METHODS FOR ANALYZING AND DETERMINING MINOR ELEMENTS: ACTIVATION ANALYSIS. Pinta, M. (Office de la Recherche Scientifique et Technique d'Outre-Mer, Bondy, France). Ann. Nutr. Aliment.; 25: No. 5, B49-52(1971). (In French).

The principle of activation analysis is reviewed, and the main applications of this method concerning nutrients are briefly described. (France)

Chemical and Spectral Procedures

Refer also to abstracts 30908, 30910, 30994, and 31198.

30666 (ANL-7868) SODIUM TECHNOLOGY QUARTERLY REPORT, JULY-SEPTEMBER 1971. Kesser, G. M. (comp. and ed.) (Argonne National Lab., Ill.). Mar 1972. Contract W-31-109-eng-38. 68p. Dep. NTIS.

Effort has continued in the national meter program to characterize the performance of an improved electrochemical oxygen meter; other work has included testing of on-line monitors for hydrogen and leak detectors for steam generators, development of a method for calibration of carbon meters, and testing of meter modules for FFTF. In the analytical standards program, RDT standards relating to specifications for measuring and controlling the purity of sodium and cover gas were prepared; laboratory work included evaluation of the uranium-getter method for determining oxygen in sodium, development of methods for characterizing particulates filtered from sodium systems, and standardization of the method for determining oxygen activity in sodium by the equilibration of vanadium wires. Development work was begun on a gas-chromatographic method for separating ^{23}Ne from noble gas fission products in cover gas and on an on-line tritium monitor; work has continued on the development of a sparging technique for monitoring the ^{135}I content of reactor primary sodium. Studies of the chemistry of liquid sodium were directed toward evaluation of vacuum distillation as a means of determining oxygen, hydrogen, and nitrogen in sodium and to elucidating phase relations in the sodium-rich corner of the Na-Na$_2$O-NaOH-NaH system. A program was started to determine the integrated effects of fast-neutron and sodium environments on the properties of stainless steel and to develop postexposure testing methods for the stainless steel specimens; work has continued in the study of carbon transport in sodium-steel systems. (auth)

30667 (SGAE-CH-78/1972) DETERMINATION OF BORON CONTENT OF ABSORBER MATERIAL IN THE FORM OF BORON CONTAINING SPHERICAL PARTICLES. Falta, G.; Bildstein, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Chemie). Jan 1972. 9p. (In German). Dep. NTIS (U. S. Sales Only).

For process control and quality control of boron-containing particles, to be used as neutron absorbers for gas-cooled high-temperature reactors, boron analyses are required. A suitable titration method was developed and is described in detail together with the obtainable accuracy and precision. (auth)

30668 (WAPD-TM-644) ELECTRON PROBE MICROANALYSIS OF IRRADIATED MATERIALS USING A SMALL SAMPLE

APPROACH. Padden, T. R.; Burton, R.; Campbell, C. E. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1967. Contract AT-11-1-GEN-14. 36p. Dep. NTIS.

A small specimen-sampling and preparation technique was developed, which is applicable to metallic and ceramic types of irradiated materials. Using this technique, specimens from preselected areas of two types of irradiated materials were prepared remotely and analyzed in an unmodified ARL electron microprobe instrument. Sample size ranged from 3.2 to 4.7 × 10^{-3} milligrams. The technique is applicable to samples previously mounted and prepared for post-irradiation metallographic evaluation. The small specimen approach was applied to a ThO_2 plus 5.3 w/o UO_2 fuel rod section irradiated to 1.6×10^{20} fissions/cc and an impurity inclusion found in the Zircaloy-4 cladding of an irradiated fuel element. The composition determination of the impurity inclusion, the detection and quantitative evaluation of a localized increase in uranium concentration near the rim of a central void in the ThO_2-UO_2 rod, the correlation of probe results with microstructure and autoradiography, and the composition analysis of solid fission products segregated in the form of "white spots" were carried out. A mechanism based on the migration of pores up the temperature gradient is proposed as an explanation for the localized increase in uranium concentration observed in the ThO_2-UO_2 rod. (auth)

30669 PHOTOMETRIC DETERMINATION OF THE NIOBIUM CONTENT OF STEEL. Schoeffmann, Ernst. Arch Eisenhuettenw.; 43: No. 1, 45-7(Jan 1972). (In German).

A working rule for the determination of the niobium content of three alloy steels and one unalloyed steel by joint work in 16 ironworks laboratories was verified. N-benzylaniline is used for separating the niobium; this is followed by photometric reaction with 1-pyridyl-2-azonaphthol. The limits of error of this method and an indication of the working directions are included. (auth)

30670 BIAMPEROMETRIC TITRATION OF INORGANIC SUBSTANCES IN NONAQUEOUS MEDIA USING PRECIPITATION REACTIONS. Bork, V. A.; Shvyrkova, L. A.; Kim, L. B. Tr. Tambov. Inst. Khim. Mashinostr., No. 4, 112-16(1970). (In Russian).

Alkaline earth metals, Ni, and Co can be titrated biamperometrically (with oxalic acid solution) in an isopropyl alcohol medium; rotating copper electrodes are used. The sequential titration of mixtures of Ca and Mg, and Sr and Ba, is possible. (Referativny Zh.)

30671 COMPLEXOMETRIC DETERMINATION OF CERIUM (III)-EDTA TITRATIONS USING ALIZARINE RED S, MUREXIDE, AND THORON INDICATORS. Dabhade, S. B.; Sangal, S. P. (Nagpur Univ., India). Indian J. Appl. Chem.; 32: No. 1, 23-4 (1969).

A detailed investigation on the complexometric determination of Ce using Thoron, Alizarine Red S, and Murexide as indicators is described. The optimum conditions, such as the effect of pH on the titre values, the range of concentration and the interference due to the foreign ions are reported. (Ind. Sci. Abstr.)

30672 SPECTROPHOTOMETRIC STUDIES OF 5,7-DICHLORO OXINE N-OXIDE COMPLEXES OF IRON(III) AND URANIUM(VI). Bhat, A. N.; Gupta, R. D.; Jain, B. D. (Delhi Univ.). Indian J. Appl. Chem.; 32: No. 1, 52-4(1969).

An ethanolic solution of 5,7-dichlorooxine N-oxide (DCONO) forms a deep brown water-soluble complex with Fe(III) salts and orange yellow soluble complex with U(VI). The 1:1 Fe(III) complex has 3 absorption maxima at 420 to 30, 500, and 650 mμ, the absorption at 420 to 30 mμ being the strongest. In the pH range 4.9 to 6.6, the (1:1) U(VI) complex has an absorption maximum at 430 mμ. Fe(III) and U(VI) complexes of DCONO each obey Lambert–Beer's law. Limits of interference due to foreign ions in the estimation of Fe and U by DCONO were determined. (Ind. Sci. Abstr.)

30673 ANALYSIS OF Ge(Li) SEMICONDUCTOR RADIATION DETECTORS USING A SPARK SOURCE MASS SPECTROMETER. Crocker, I. H.; Wray, L. W. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. Spectrosc.; 16: No. 3, 77-80(May 1971). (AECL-3877).

Spark-source mass spectrometry was used to determine ultratrace contaminants in single-crystal germanium. The Ge single crystals were grown with extreme care from zone-refined ingots in a controlled atmosphere to minimize contamination and enhance their efficiency as radiation detectors when drifted with Li. It was found that spark-source mass spectrometry could be used to distinguish Ge of high purity, which made the best detectors, from Ge of lesser purity, which made inferior detectors, although the technique was necessarily used at its utmost limits of sensitivity. An inhomogeneous distribution of impurity elements in the Ge single-crystal matrix was demonstrated. (auth)

30674 NIOBIUM DETERMINATION IN CASSITERITE AND IN CASSITERITE ORES (EXCHANGE OF EXPERIENCE). Dobkina, B. M.; Kuchmistaya, G. I.; Nadezhdina, G. B. (State Scientific-Research and Development Inst. for the Rare Metals Industry, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 9, 1331-2(Sep 1971).

Translated from Zavod. Lab.; 37: No. 9, 1049-50(Sep 1971).

For the determination of trace amounts of niobium, cassiterite was decomposed completely by fusion with potassium hydrofluoride and/or sodium pyrosulfate. The melt was dissolved, and the niobium content determined photometrically using pyridylresorcinol. (J.G.B.)

30675 KINETIC METHOD FOR THE DETERMINATION OF CERIUM. Zhukov, Yu. A.; Milyukova, A. P. (Ivanovo Chemical Tech. Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 15: No. 3, 449-50(1972). (In Russian).

A method for determining Ce^{3+} is based on the ability of the latter to catalyze the reaction $21^- + H_2O_2 + 2H^+ = I_2 + 2H_2O$ at room temperature. The method had a possible error of ±10%, and suffered interference by HCO_3^-, VO_3^-, Fe^{2+}, and Mn^{2+} ions. Ions such as SO_4^{2-}, Mg^{2+}, K^+, Na^+, and Cu^{2+} did not interfere. (K.S.W.)

30676 SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM, URANIUM, THORIUM, AND RARE EARTHS WITH ARSENAZO III AFTER EXTRACTIONS WITH THENOYLTRIFLUOROACETONE AND TRI-n-OCTYLAMINE. Onishi, Hiroshi; Sekine, Keiichi (Japan Atomic Energy Research Inst., Tokai). Talanta; 19: No. 4, 473-8(Apr 1972).

A method is described for the spectrophotometric determination of microgram amounts of zirconium, uranium(VI), thorium and rare earths with Arsenazo III after systematic separation by extraction. First zirconium is extracted into a xylene solution of thenoyltrifluoroacetone (TTA) from about 4M hydrochloric acid. Uranium(VI) is then extracted into a xylene solution of tri-n-octylamine from about 4M hydrochloric acid. Thorium is next extracted into TTA solution at pH about 1.5, and finally rare earths are extracted into TTA solution at pH about 4.7. Each metal is back-extracted from the organic phase before determination. (auth)

30677 FLAME SPECTRA OF FLUORINE COMPOUNDS. Gutsche, B.; Herrmann, R. (Univ., Giessen, Ger.). Z. Anal. Chem.; 258: No. 4, 277-80(1972). (In German).

Flame band spectra of F compounds with Ba, Ca, Cu, Mg, and Sr are presented. Other band F spectra (with B, Be, Bi, I, La, Mn, Pb, S, Sb, Si, and Te) could not be observed. The intensities and the intensity background ratios for the first compounds in different flames are tabulated. The best F bands for F analysis are pointed out. (auth)

30678 INDIRECT PHOTOMETRIC DETERMINATION OF SMALL AMOUNTS OF IODINE IN SELENIUM. Ernst, O.; Szolnoki, G. (Siemens AG, Erlangen, Ger.). Z. Anal. Chem.; 258: No. 4, 263-6(1972). (In German).

After separation of selenium by precipitation with ferrous iron, the iodine is employed for catalyzing the Ce^{4+}/As^{3+} redox reaction. This is stopped by ferrous iron and the ferric iron formed is determined by photometry as thiocyanate. This method enables the determination of about 100 ± 6 ng of iodine in 5 to 10 mg of selenium. The method was applied for determination of the distribution of iodine in Se rectifier layers. The layers were dissolved by etching with a solution of alkali cyanide. The usual doping elements showed no disturbance. (auth)

30679 DETERMINATION OF CALCIUM IN THE HIGH-MELTING METALS TUNGSTEN AND MOLYBDENUM BY ATOMIC ABSORPTION SPECTROMETRY. Neumann, Gerhard M. (OSRAM-Studiengesellschaft, Munich). Z. Anal. Chem.; 258: No. 3, 180-5(1972). (In German).

Results of atomic-absorption studies of calcium in tungsten and in molybdenum in the presence of alkali, aluminum, and silica are reported. The interferences of the accompanying elements are compensated by the addition of cesium and strontium. Thus, AAS can be applied without prior separation procedure for the determination of calcium in tungsten and in molybdenum in the presence of impurities of sodium, potassium, aluminum, and silica. The sensitivity found was 0.2 μg Ca/ml solution, or 20 ppM Ca in the solid metal. (auth)

30680 COLORIMETRIC DETERMINATION OF MICRO AMOUNTS OF URANIUM(VI) AND THORIUM(IV) WITH DITHIZONE. Malik, Wahid U.; Sharma, T. C. (Univ. of Roorkee, India). Z. Anal. Chem.; 258: No. 2, 124-5(1972).

The maximum absorption of the uranyl and thorium complexes were found at 480 and 500 nm, respectively. Beer-Lamberts' law was followed up to a concentration of 5 ppM for uranium and 3.5 ppM for thorium. Interferences by foreign ions were studied and tolerance limits determined. (M.C.G.)

30681 TRIPHENYLMETHANE DYES AS REDOX INDICATORS IN CERATE OXIDIMETRY. TITRATION OF Fe(II), U(IV), V(IV), As(III), OXALATE AND HYDROQUINONE. Dutt, V. V. S. Eswara; Rao, N. Venkateswara (Andhra Univ., Waltair, India). Z. Znal. Chem.; 258: No. 1, 32(1972).

30682 DECOMPOSITION WITH SODIUM CARBONATE. Bock, Rudolf; Ali, Syed Laik (Johannes Gutenberg-Univ., Mainz). Z. Anal. Chem.; 258: No. 1, 12-15(1972). (In German).

After decomposition with sodium carbonate and extraction of the melt with water, traces of many different elements are found in the filtrate, chiefly because very small particles are not retained quantitatively by the filters. The partition of silicic acid between solution and residue and the volatilities of several compounds were tested. Use of this method in determination of several elements, including I, Zr, and Sr, is discussed. (M.C.G.)

30683 ARGENTIMETRIC TITRATION OF IODIDE AND CHLORIDE IN ADMIXTURE. Aliotta, G.; Casal, A. R. (Univ. Nacional del Sur, Bahia Blanca, Argentina). An. Asoc. Quim. Argent.; 59: No. 1, 7-9(1971). (In Spanish).

The test solution is adjusted to pH 5 with Na acetate–acetic acid and diluted to 100 ml; 10 drops of 0.2% ethanolic iodophenol blue are added, and the solution is titrated with $AgNO_3$ solution. When the first end point is reached (titration of I^-) 6 drops more of indicator solution are added, the pH is adjusted to 1 with HNO_3, and titration is continued to a second end point (for Cl^-). A microscale procedure is also given. (Anal. Abstr.)

30684 INHIBITORS OF THE IONIZATION OF LANTHANUM IN ATOMIC-ABSORPTION SPECTROPHOTOMETRY. Aliotta, G.; Reale, C. A. (Univ. Nacional del Sur, Bahia Blanca, Argentina). An. Asoc. Quim. Argent.; 59: No. 1, 11-19(1971). (In Spanish).

The addition of alkali metal salts to a solution being analyzed for La by atomic absorption (N_2O–acetylene flame) reduces the extent of ionization of La in the flame and enhances the sensitivity. The maximum absorption (at the level of 600 ppM of La) is obtained by making the solution 0.1 M in CsCl, 0.2 M in NaCl or KCl, or 0.3 M in LiCl. The effect of mixtures of salts of Ba and Mg was also examined. (Anal. Abstr.)

30685 CONTINUOUS POLAROGRAPHY [OF URANIUM] IN PROCESS SOLUTIONS. Baumgaertel, Guenter (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). Chem.-Ztg., Chem. App.; 95: No. 8, 356-8(1971). (In German).

The process sample (e.g., from the working-up of irradiated nuclear fuels), which is M to 2M in HNO_3, is mixed with 20% of its volume of a mixture (1 : 1) of methanol (to destroy NO_2^-) and saturated aqueous ascorbic acid (to reduce Fe^{3+}). After passage of N, the current at –0.25 V vs. the S.C.E. is measured polarographically. A series of valves allows a sequence of samples to pass through the polarographic cell. When the method was applied to on-line determination of U (mM), the coeff. of variation was 2.2%. The calibration graph is rectilinear for 0.1 to 2mM–U. (Anal. Abstr.)

30686 SEPARATION AND DETERMINATION OF HALIDE IONS IN THE SOLID SOLUTIONS THALLIUM(I) BROMIDE–THALLIUM(I) IODIDE AND THALLIUM(I) CHLORIDE–THALLIUM(I) BROMIDE. Gosteva, L. I.; Khokhrina, E. T. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 29: 124-37(1970). (In Russian).

Treatment of an aqueous SO_4^{2-}-containing solution of mixed halides of Tl with zinc dust causes deposition of the Tl on the zinc, and the halides remain in solution. To determine Br^- and I^- separately in this solution, iodide is oxidized by $NaNO_2$ to free iodine, which is expelled by boiling and absorbed in Na_2SO_3 solution. In the residual I^--free solution and in this Na_2SO_3 solution, Br^- and I^- are determined gravimetrically as AgBr and AgI, respectively. For the separate determination of Cl^- and Br^-, the bromide is oxidized to free Br, which is boiled out and collected in Na_2SO_3 solution. The Br^--free solution and the absorbent solution are analyzed gravimetrically for Cl^- and Br^-, respectively, as AgCl and AgBr. (Referativnyi Zh.)

30687 USE OF METHYL BLUE EXTRACTION-PHOTOMETRIC DETERMINATION OF URANIUM(VI). Shchemeleva, G. G.; Bagdasarov, K. N.; Stepanenko, Yu. V. (Rostov State Univ., Rostov-on-Don, USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 15: No. 1, 38-41(1972). (In Russian).

A colored ionic complex is formed in the system uranium–sodium benzoate–Methyl Blue, and may be extracted by a 1 : 1 benzene–$CHCl_3$ mixture. The influences of the nature of the organic solvent, the pH, reagent concentration, and other factors were studied. The light absorption of blank extracts was low; the absorption spectrum of the extracted complex was characterized by a narrow band at 650 nm. The optimum pH = 3.9, which may be provided by the addition of 1 ml of 0.1 N HCl/ml of aqueous phase. (K.S.W.)

30688 SEPARATION OF METAL IONS FROM DIETHYLENETRIAMINE-N,N,N',N'',N''-PENTAACETIC ACID BY A CATION EXCHANGER. Zukriegelova, M.; Sulcek, Z.; Povondra, P. (Geological Inst., Prague). Collect. Czech. Chem. Commun.; 37: No. 2, 560-8(Feb 1972). (In German).

The behavior of the following ions on a cation exchange resin in the presence of diethylenetriamine-N,N,N′,N′′,N′′-pentaacetic acid was studied: Tl^+, Ca^{2+}, Mg^{2+}, Zn^{2+}, Pb^{2+}, Co^{2+}, Ni^{2+}, Mn^{2+}, UO_2^{2+}, In^{3+}, Fe^{3+}, and Th^{4+}. The ion exchange resin was the Na form of Dowex 50-WX-8 which had been loaded into a 10-mm-dia column. The chromatographic process may be used for Th determination in uranyl nitrate, for Fe and Mn determination in zinc blende, and for the assay of Fe, Zn, and Co in pyrolusite. (tr-auth)

30689 PHOTOMETRIC MICROTITRATIONS. V. INFLUENCE OF THE CONCENTRATION OF THE METAL AND THE METALLOCHROM INDICATORS ON THE FORM OF THE TITRATION CURVE. Kotrly, S.; Vachta, J. (Technische Hochschule fuer Chemie, Pardubice, Czech.). Collect. Czech. Chem. Commun.; 37: No. 2, 550-9(Feb 1972). (In German).

Conditions were studied for influencing the slope of the linear portion of the titration curve before the equivalence point in the complexometric titration of metal ions with metallochrom indicators. Results are given for photometric titration of Bi, Th, and Pb using Xylenol Orange. (M.C.G.)

30690 MASS SPECTROMETRY: TECHNIQUES AND APPLICATIONS. Milne, George W. A. (ed.). New York; John Wiley and Sons, Inc. (1971). 529p.

A collection of critical reviews of the various areas of organic mass spectrometry is presented. Topics covered include: automatic acquisition and processing of mass-spectral data, photographic techniques, electrical recording of magnetically scanned high-resolution mass spectra, computer-assisted interpretation of the spectra, gas chromatography and mass spectrometry, application of artificial intelligence to interpretation of the spectra, newer ionization techniques, mass-spectral studies using stable isotopes in chemistry and biochemistry, mass spectrometry in peptide chemistry, applications of mass spectrometry to problems in medicine and biochemistry, mechanism studies of fragmentation pathways, and some aspects of metastable transitions. Author and subject indexes are included. (M.C.G.)

30691 DETERMINATION OF HYDROGEN IN A HIGH TEMPERATURE FLUID AND APPARATUS THEREFOR. Holden, Robert B.; Fuhrman, Nathan (to United States Atomic Energy Commission). U. S. Patent 3,649,473. 14 Mar 1972. Filed 8 Dec 1969.

The hydrogen activity of a high-temperature fluid such as liquid sodium is measured by immersing thereinto a probe that forms an equilibrium electrolytic cell. The probe comprises a closed-end metal tube that is impervious to the fluid. The tube is provided with a hydrogen sensing electrode portion that is permeable to hydrogen. Inside the tube is a hydrogen reference electrode electrically insulated therefrom. The space between the closed end of the probe and the reference electrode is filled with a fused salt electrolyte containing an oxygen-bearing ion that reacts with elemental hydrogen. A potentiometer measures the difference in electrical potential between the sensing electrode and the reference electrode to provide an accurate measure of the hydrogen activity of the fluid. (Official Gazette)

30692 SPECTROCHEMICAL DETERMINATION OF ZIRCONIUM AND HAFNIUM IN MAGNESIUM AND ITS ALLOYS. Zhivopistsev, V. P.; Petrov, B. I.; Sibiryakov, N. F. Uch. Zap., Perm. Gos. Univ.; No. 207, 144-51(1970). (In Russian).

The Zr and Hf are selectively extracted from the sample solution containing 3 to 7% NH_4SCN using diantipyrinylmethane solution in $CHCl_3$. The extract is filtered, and the Zr and Hf are reextracted with 1.5% oxalic acid solution in N-H_2SO_4. To the resulting solution are added a solution of a Nb salt (as internal standard) and graphite powder. The mixture is evaporated, the residue is calcined, then placed in the channel of a carbon electrode, and the spectrum is excited in an ac arc (8 to 11 A). Down to 10 ppM each of Zr and Hf can be determined in a 1-g sample with an error of ≈10%. (Referativnyi Zh.)

30693 STABLE ISOTOPE DILUTION: A POWERFUL ANALYTICAL TECHNIQUE. Mathews, C. K. (Bhabha Atomic Research Centre, Trombay, India). pp 197-209 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

The isotope dilution technique, the scope for its application, and the instrumental requirements are discussed. The advantages and disadvantages of this technique as compared to other analytical techniques are pointed out. Applications in trace analysis, nuclear chemistry, geochemistry, cosmochemistry, etc., are illustrated from recent work in this field. (auth)

30694 DETERMINATION OF RARE EARTHS IN URANIUM BY STABLE ISOTOPE DILUTION. Chitambar, S. A.; Shah, P. M.; Mathews, C. K. (Bhabha Atomic Research Centre, Bombay). pp 211-15 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

An isotope dilution method for determination of neodymium, samarium, and gadolinium at sub-microgram levels was developed. The method involves isotopic dilution with enriched isotopes of samarium and gadolinium followed by separation of the rare earths from uranium. A mass spectrometer with thermionic source was used to determine the relative isotopic abundances in each of these rare earths. Chemical separation of the individual rare earths from each other is not required. Trace concentrations in the ppM to ppB range can be measured. The method can easily be extended to include other rare earths. (auth)

30695 DETERMINATION OF PLUTONIUM BY MASS SPECTROMETRIC ISOTOPE DILUTION. Mathews, C. K.; Chitambar, S. A.; Shah, P. M. (Bhabha Atomic Research Centre, Trombay, India). pp 217-21 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

Determination of plutonium in solutions of low concentrations is of considerable importance. Mass spectrometric isotope dilution was used for this determination. Solutions containing submicrogram levels of reactor-produced plutonium are isotope diluted with known amounts of ^{242}Pu. The ^{239}Pu/^{242}Pu ratio in this sample is measured mass spectrometrically and the amount of plutonium in the original sample is calculated. The precision and accuracy of this method of measurement are discussed. (auth)

30696 ESTIMATION OF URANIUM AND THORIUM IN SOLUTIONS BY X-RAY FLUORESCENCE ANALYSIS. Dias, R. M. A.; Chawla, K. L.; Jayadevan, N. C.; Chaskraburtty, D. M. (Bhabha Atomic Research Centre, Bombay). pp 223-8 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

For control of the process solutions in reactor fuel reprocessing, the feasibility of the x-ray fluorescence method for estimation of uranium and thorium is being investigated. Uranium solutions of varying concentrations ranging from 15 μg/ml to 5 mg/ml were taken in sample holders of 1.6-ml capacity covered with mylar foil and examined in the x-ray spectrograph. The intensities of the L alpha line were measured. Thorium used as an internal standard in the estimation of uranium and plutonium was studied under similar conditions. The effect of thorium on the estimation of uranium was also studied by taking mixed solutions of these elements in various concentrations. The standard curves were obtained in all cases. The method of analysis, in general, is very rapid and the results are highly reproducible. It is suited for online analysis work. In the higher and middle concentration ranges the standard deviations were between 0.10 and 0.4%, but in the region 15 μg to 50 μg/ml, it was around 0.9%. (auth)

30697 ANION EXCHANGE SEPARATION AND SPECTROGRAPHIC DETERMINATION OF RARE EARTHS IN PLUTONIUM AND THE EFFECT OF PLUTONIUM AND OTHER NON-RARE EARTH ELEMENTS ON THEIR ESTIMATION. Joshi, B. D.; Patel, B. M.; Page, A. G. (Bhabha Atomic Research Centre, Trombay, India). pp 229-36 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

An emission spectrochemical method was developed for the determination of all rare earths at ppM level in plutonium samples using a LiF–AgCl–graphite powder mixture as carrier. The rare earths were chemically separated from plutonium using anion exchange resin Dowex-I with 7.2M nitric acid. The effluent containing rare earths was concentrated and used for spectrographic estimation. The samples were excited in an atmosphere of air/argon–oxygen gas mixture. The recovery by this procedure was checked radiochemically using $^{152-154}$Eu tracer and spectrographically using synthetic samples and was found to be quantitative. The effect of microgram quantities of plutonium and other general impurities on the detection limits and estimation ranges was investigated. One hundred ppM each of plutonium and 12 general impurity elements do not alter the detection and estimation ranges. The detection limits in ppM based on 100 mg plutonium sample are: Ce, Pr, Tb: 5; Eu, Gd: 0.5; Nd, Sm, Dy, Ho: 2.5; Yb: 0.1; and Er, Lu: 1.25 ppM. The precision of this method expressed as a coefficient of variation is estimated to be ±10%. (auth)

30698 RADIOCHEMICAL STUDIES IN SOLVENT EXTRACTION SEPARATION OF IMPURITIES FROM HIGH PURITY SELENIUM AND THEIR ESTIMATION SPECTROGRAPHICALLY. Joshi, B. D.; Bangia, T. R.; Dalvi, A. G. I. (Bhabha Atomic Research Centre, Trombay, India). pp 237-43 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

The impurities Pb, Bi, Cr, Co, Ni, Zr, Mo, As, Sb, Ba, Fe, Cu, and Ti in 1 gm of high-purity selenium were separated by solvent extraction using dithizone in CCl_4. Quantitative recovery of the impurities was checked by radioactive tracers for Ba, Co, Mo, and Zr and spectrographically for all elements. The aqueous phase containing the impurities was evaporated to dryness. The residue was dissolved in 6M HCl. Some of this solution was loaded on a mixture containing 9.1 mg graphite and 0.9 mg NaCl, in the electrode crater for estimation by emission spectrography. The spectra were excited by a dc arc carrying 13 ampere current. Tin was used as internal standard. The detection limits obtained are given in ppM: Bi, Ni, Mo: 0.02; Cu, Co, Cr, Fe: 0.1; Ba, Ti, Pb, Zr: 0.2; and Sb, As: 0.4. The results obtained for crude and vacuum distilled selenium samples are also reported. (auth)

30699 AMPEROMETRIC TITRATION METHOD FOR THE DETERMINATION OF URANIUM IN PUREX PROCESS STREAM. Venkatasubramanian, V.; Perumal, K. (Bhabha Atomic Research Centre, Trombay, India). pp 245-54 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

Precise and accurate determination of uranium in the process stream samples of a reprocessing plant is essential for an efficient plant control and nuclear material management. With this in view, an amperometric titration technique was developed. The method consists of reducing uranium to U(IV) by Fe(II) in a phosphoric acid medium followed by oxidizing it with Cr(VI) to U(VI) in a mixed sulfuric–phosphoric acid medium. The titration is followed by drop in anodic current of U(IV) ions at an applied potential of +700 mV at a rotating platinum microelectrode. Interferences due to foreign ions, optimum reagent concentration, electrode treatment, and effect of standing at different stages of the procedure were studied. A discussion of the electrode behavior and results of analysis of standards and process stream samples are also presented. The rapidity, extreme sensitivity of end point detection, insensitivity to most ions associated with uranium in the process stream, and a very high order of precision and lack of bias are factors in favor of this method. (auth)

30700 AMPEROMETRIC TITRATION METHOD FOR THE ASSAY OF PLUTONIUM OXIDE SAMPLES. Venkatasubramanian, V.; Perumal, K. (Bhabha Atomic Research Centre, Trombay, India). pp 255-62 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

An amperometric titration technique was investigated for precise and accurate determination of plutonium in the end product oxide samples from the reprocessing plant which is essential for an efficient nuclear material management. The method consists of oxidizing plutonium to Pu(VI) by argentic oxide in nitric acid medium followed by reducing it with Fe(II) to Pu(IV) in a mixed sulfuric–phosphoric acid medium. The titration is followed by the anodic current due to free Fe(II) ions, beyond equivalence point, at an applied potential of +600 mV at a rotating platinum microelectrode. Further confirmation of the end point can be obtained by titrating the excess Fe(II) with Cr(VI) to a steady low residual current. Interferences due to foreign ions, optimum reagent concentration, electrode treatment, effect of standing at different stages of the procedure were all studied. A discussion of electrode behavior and results of analysis of standards and oxide samples are also presented. Results indicate that the method compares favorably with controlled potential coulometry and potentiometry and is therefore excellently suited for adoption into routine use. (auth)

30701 POTENTIOMETRIC ESTIMATION OF PLUTONIUM UNDER SIMULATED CONDITIONS OF DISSOLVER SOLUTIONS. Nair, G. M.; Singh, N. P.; Chander, Keshav; (and others) (Bhabha Atomic Research Centre, Trombay, India). pp 263-7 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

A potentiometric method involving oxidation of plutonium to Pu(VI) and indirect titration with Ce(IV) after addition of known excess of Fe(II) was developed for estimation of plutonium in the presence of large concentrations of uranium (U/Pu 1000) as encountered in dissolver solutions, after effecting quantitative separation of plutonium by anion exchange. The effects of fission products were also studied. Plutonium was loaded on the anion exchanger (Dowex-1 X -4) from 7.2 M HNO_3 and was washed free from impurities with HNO_3 of the same concentration. Various eluting agents such as 0.5M HNO_3, 0.35M HNO_3, 0.2M H_2SO_4, 1M CH_3COOH, a mixture of 0.1M HNO_3 and 0.01M HF and a solution of 0.5M $(NH_2OH)_2$ H_2SO_4 in 0.35M HNO_3 at room temperature as well as at 60°C were studied for the quantitative elution of plutonium. Elution with 0.35 M HNO_3 at 60°C was found to be most satisfactory for the estimation of plutonium by this method. (auth)

30702 ANHYDROUS PLUTONIUM(IV) SULPHATE AS A POSSIBLE PRIMARY STANDARD FOR PLUTONIUM. Ramaniah, M. V.; Nair, G. M.; Singh, N. P.; Sharma, K. C.; Joshi, J. K. (Bhabha Atomic Research Centre, Trombay, India). pp 269-74 of proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

Pure anhydrous plutonium sulfate was prepared from plutonium purified by anion exchange and hydroxide precipitation followed by peroxide precipitation. The plutonium peroxide was dissolved in 2M H_2SO_4 by heating. The solution, on evaporation, gave pink crystals of plutonium sulfate. These crystals were heated in a furnace at 325 ± 5°C to get the anhydrous salt. The composition of this salt was checked by estimating plutonium and sulfate by standard potentiometric methods. Various lots of anhydrous plutonium sulfate prepared by the above method showed a consistency of composition within the accuracy of the methods used for the analysis (better than 0.2%). Therefore, it is proposed that anhydrous plutonium sulfate prepared as above could be used as a primary standard for the estimation of plutonium. (auth)

30703 SEPARATION AND DETERMINATION OF URANIUM AT MICROGRAM LEVEL IN PLUTONIUM NITRATE SOLUTIONS. Chitnis, R. T.; Chitale, S. G.; Dakshinamoorthy, A. (Bhabha Atomic Research Centre, Trombay, India). pp 275-82 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

A separation procedure was developed to facilitate the spectrophotometric and fluorimetric determination of microgram and sub-microgram quantities of uranium in the presence of milligram amounts of plutonium. Uranium is extracted by trioctylphosphine oxide in cyclohexane from a nitric acid solution containing ferrous sulfamate and hydroxylamine sulfate. Plutonium present in the sample is retained in the aqueous phase in the reduced state and uranium alone is extracted in the organic phase. From the organic extract, uranium is directly determined either by spectrophotometry or by fluorimetry depending on the uranium concentration. For samples containing 0.5% or more or uranium, the spectrophotometric method using dibenzoylmethane was adopted, whereas for samples containing lesser amounts of uranium, the fluorimetric method was used. It was found possible to determine as low a uranium content as 1 ppM. The decontamination factor for plutonium is more than 10^5, which enables the rest of the operations to be carried out with negligible amounts of contamination. The recovery of uranium is quantitative. (auth)

30704 MICROWAVE SPECTROSCOPY. Scharpen, LeRoy H. (Hewlett-Packard Co., Palo Alto, Calif.); Laurie, Victor W. Anal. Chem.; 44: No. 5, 378R-84R(Apr 1972).

The review emphasizes those aspects of microwave spectroscopy that bear on analytical applications. Topics covered include: basic considerations, rotational energies, absorption line intensities and shapes, instrumentation, band spectra, isotope effects applications, and other applications. (45 references) (M.C.G.)

30705 THERMAL ANALYSIS. Murphy, C. B. (Xerox Corp., Rochester, N. Y.). Anal. Chem.; 44: No. 5, 513R-24R (Apr 1972).

The major trends in thermal analysis from late 1969 to October 1971 are reviewed. Topics covered include: differential thermal analysis, thermogravimetric analysis, electrothermal analysis, dilatometry, and evolved gas analysis. (364 references) (M.C.G.)

30706 TITRATIONS IN NONAQUEOUS SOLVENTS. Lagowski, J. J. (Univ. of Texas, Austin). Anal. Chem.; 44: No. 5, 524R-34R(Apr 1972).

The literature for the period November 1969 through October 1971 is reviewed. The subject is discussed with reference to individual solvent types: hydrocarbons and aprotic derivatives, alcohols, ethers, ketones, acids, esters, acid amines, amines, nitriles, sulfones, dimethyl sulfoxide, and molten salts and other aprotic solvents. A summary of the titrations reported and the methods used to follow the course of reaction are given. Relative acidity, solution phenomena, and experimental techniques are discussed. (282 references) (M.C.G.)

30707 ULTRAVIOLET SPECTROMETRY. Hummel, Richard; Kaufman, Donald (Dow Chemical Co., Midland, Mich.). Anal. Chem.; 44: No. 5, 535R-43R(Apr 1972).

The literature from December 1969 to December 1971 is reviewed. Topics covered include: collections of spectra and indices, apparatus, spectra studies of classes of compounds, adsorbed molecules, vacuum ultraviolet spectrometry, solvent and pH effects, solution equilibria, reaction mechanisms, reaction rates, theory and calculations, elucidation of structure, complexes, inorganic analysis, organic analysis, biological analysis, and pharmaceutical analysis. (388 references) (M.C.G.)

30708 X-RAY ABSORPTION AND EMISSION. Birks, L. S. (Naval Research Lab., Washington, D. C.). Anal. Chem.; 44: No. 5, 557R-62R(Apr 1972).

Micro and trace analysis, absolute x-ray intensities, quantitative analysis, heterogeneous samples, improved parameters, instrumental improvements, electron and ion probes, valence and bonding effects, and low atomic number elements are discussed. Conclusions from advances in the past two years are presented. (86 references). (M.C.G.)

30709 X-RAY DIFFRACTION. Pfluger, C. E. (Syracuse Univ., N. Y.). Anal. Chem.; 44: No. 5, 563R-72R(Apr 1972).

A general view is presented of the field of x-ray diffraction with emphasis on the directions in which applications and research in areas of instrumentation, analysis, powder methods, topographic methods, determination of structure, etc., have been going. (351 references). (M.C.G.)

30710 MASS SPECTROMETRY. Burlingame, A. L.; Johanson, Gary A. (Karolinska Institutet, Stockholm). Anal. Chem.; 44: No. 5, 337R-78R(Apr 1972).

Developments in mass spectrometry are reviewed. Topics covered include: computer techniques, gas chromatography–mass spectrometry combination, ion cyclotron resonance, molecular fragmentation, molecular ionization other than electron impact, isotope labeling, mass spectrometry in bio-organic chemistry and biomedical research, mass spectra of organo-inorganic compounds, inorganic mass spectrometry, mass spectrometry in organic geochemistry, isotope ratios and geochonology, applications to cosmochemistry, and organic mass spectrometry. (1743 references). (M.C.G.)

30711 MAGNETIC SUSCEPTIBILITY: INSTRUMENTATION AND APPLICATIONS INCLUDING LUNAR AND BIOTYPE. Mulay, L. N.; Mulay, Indumati L. (Pennsylvania State Univ., University Park). Anal. Chem.; 44: No. 5, 324R-37R(Apr 1972).

The trends in instrumentation and applications to chemistry, including solid state and lunar studies, are surveyed. The literature from January 1970 to December 1971 is covered. New trends, new units for magnetic quantities, instrumentation, and applications are discussed. (114 references). (M.C.G.)

30712 LIGHT ABSORPTION SPECTROMETRY. Boltz, D. F. (Wayne State Univ., Detroit); Mellon, M. G. Anal. Chem.; 44: No. 5, 300R-23R(Apr 1972).

The significant developments in analytical, light absorption spectrometry for the period from November 1969 through November 1971, as documented by Chemical Abstracts, are reviewed. The subject matter is classified under the topics of chemistry, physics, and applications. (886 references). (M.C.G.)

30713 INORGANIC ANALYSIS. West, Philip W.; West, Foymae K. (Louisiana State Univ., Baton Rouge). Anal. Chem.; 44: No. 5, 251R-55R(Apr 1972).

Microchemical and trace methods, as well as other conventional chemical methods of analysis including titrimetry and gravimetry applied to macro amounts of sample, are reviewed. (112 references). (M.C.G.)

30714 FLUOROMETRIC ANALYSIS. White, Charles E. (Univ. of Maryland, College Park); Weissler, Alfred. Anal. Chem.; 44: No. 5, 182R-206R(Apr 1972).

Literature covering the period December 1969 to December 1971 is reviewed. Topics covered include: apparatus, inorganic analyses (Al, Be, B, Ca, Ba, Li, Mg, Cu, Ag, Au, Bi, Cd, Pb, Hg, Ga, In, Tl, Fe, Co, Ni, Mn, Cr, Pt metals, Ge, Sb, Sn, Mo, Nb, Ta, Re, U, Ti, Zr, Hf, Th, Zn, rare earths, nonmetals), and organic and biological analyses. (1073 references). (M.C.G.)

30715 FLAME SPECTROMETRY. Winefordner, J. D. (Univ. of Florida, Gainesville); Vickers, T. J. Anal. Chem.; 44: No. 5, 150R-82R(Apr 1972).

Papers published in 1970 and 1971 of a fundamental or general methodological nature and directly related to or useful in flame spectroscopy are reviewed. Topics covered include: fundamental studies, atomic and molecular emission spectrometry, and atomic absorption spectrometry. (674 references). (M.C.G.)

30716 EMISSION SPECTROMETRY. Barnes, Ramon M. (Univ. of Massachusetts, Amherst). Anal. Chem.; 44: No. 5, 122R-50R(Apr 1972).

References covering 1970 and 1971 are reviewed. A general summary of new books, review articles, and spectral atlases is given. Spectral descriptions and classification, instrumentation, standards and calibration, calculations, excitation sources, and spectrochemical analysis are discussed. (991 references). (M.C.G.)

30717 ELECTROANALYSIS AND COULOMETRIC ANALYSIS. Davis, Donald G. (Louisiana State Univ., New Orleans). Anal. Chem.; 44: No. 5, 79R-84R(Apr 1972).

The literature appearing in 1970 and through mid-December 1971 is reviewed. Topics covered include: recent trends, electroseparations and electrogravimetry, controlled potential coulometry, controlled-current coulometry and coulometric titrations, and apparatus. (228 references). (M.C.G.)

30718 ELECTROCHEMICAL RELAXATION TECHNIQUES. Roe, D. K. (Oregon Graduate Center, Beaverton). Anal. Chem.; 44: No. 5, 85R-96R(Apr 1972).

Four years of publications are reviewed. Topics covered include: theory of electrochemical relaxations, controlled potential, controlled current, impedance techniques, hydrodynamic techniques, coulostatic techniques, and other relaxation techniques. (400 references). (M.C.G.)

30719 AMPEROMETRIC TITRATIONS. Stock, John T. (Univ. of Connecticut, Storrs). Anal. Chem.; 44: No. 5, 1R-9R(Apr 1972).

The period of time covered is from the previous review (Anal. Chem.; 42: 276R(1970)) through October 1971. Topics covered include: apparatus and methodology; acid-base reactions; precipitation and complexing reactions (methods involving lead, hexacyanoferrate(II), molybdenum and tungsten, EDTA or analogous reagents, and other organic compounds); and oxidation-reduction reactions (methods involving iron, cerium, titanium, vanadium, chromium, manganese, chlorine or bromine, and iodine). (347 references). (M.C.G.)

30720 PROCEDURES FOR THE DETERMINATION OF BURN-UP BY CHEMICAL METHODS AND NUCLEAR DATA REQUIREMENTS IN BURN-UP CALCULATIONS. Fudge, A. J.; Foster, E. (Atomic Energy Research Establishment, Harwell, Eng.). pp 65-74 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

Methods of chemical burn-up determination are reviewed and some current problems are outlined. Nuclear data required in burn-up determinations are examined. Assessments of existing fission yield data for burn-up determinations in thermal reactor-type neutron fluxes show that the required standards of precision and accuracy are almost met. Far less data are available for irradiations in fast reactor neutron fluxes; and, consequently, more results are needed both for the absolute values of neutron cross sections and fission yields and for the variations of these with neutron energy before the required standards can be satisfied. (53 references) (auth)

30721 RAMAN SPECTROMETRY. Hester, Ronald E. (Univ. of York, Eng.). Anal. Chem.; 44: No. 5, 490R-7R(Apr 1972).

The literature that appeared between late 1969 and late 1970 is covered. Topics discussed include: experimental techniques, intensities, resonance Raman effects, solvent effects and band shapes, solid state, gases, matrix isolation, surface adsorption, inorganic compounds, organometallics, organic compounds, and electronic, stimulated, hyper-, and inverse Raman effects. (288 references). (M.C.G.)

30722 NUCLEAR MAGNETIC RESONANCE SPECTROMETRY. Corio, P. L.; Smith, S. L.; Wasson, J. R. (Univ. of Kentucky, Lexington). Anal. Chem.; 44: No. 5, 407R-38R(Apr 1972).

The literature from July 1969 to July 1971 is reviewed. Topics covered include: chemical shifts, spin–spin coupling constants, spectral analysis, multiple resonance and multiple quantum transitions, chemically induced dynamic nuclear polarization (CIDNP), spin echoes, Fourier transform methods, relaxation, chemical exchange, solids and surfaces, instrumentation, NMR in inorganic and organic chemistry, and solvent phenomena. (1978 references). (M.C.G.)

30723 ION SELECTIVE ELECTRODES, POTENTIOMETRY, AND POTENTIOMETRIC TITRATIONS. Buck, Richard P. (Univ. of North Carolina, Chapel Hill). Anal. Chem.; 44: No. 5, 270R-95R(Apr 1972).

Emphasis in this review is on ion selective electrodes and their applications in all fields of applied science. Standard potentials in nonaqueous and mixed solvents, fundamental papers on potentiometry in mixed solvents, and principles of membrane potentials are discussed. Titration curve analysis and equilibrium calculations, nonglass solid-state electrodes, uses of fluoride ion-selective electrodes, uses of homogeneous silver salt membrane electrodes, glass electrodes, sensitized electrodes using interposed chemical reactions, ion-sensitive semiconducting electrodes, liquid ion exchange membrane electrodes, uses of liquid membrane electrodes, conventional electrodes in aqueous media, potentiometric electrode behavior in nonaqueous and mixed solvents, and inorganic potentiometric titrations are discussed. (1037 references). (M.C.G.)

30724 SOME NEW APPLICATIONS OF THE LANDOLT EFFECT IN KINETIC METHODS OF CHEMICAL ANALYSIS. [DETERMINATION OF MOLYBDENUM, TIN, PALLADIUM, SILVER, HYDROGEN PEROXIDE, AND ALKALINITY]. Vajgand, Vilim J.; Stojanovic, Dimitrije D.; Jelenic, Durde B. (Univ., Belgrade). Bull. Soc. Chim. Beograd; 35: No. 2-3, 223-36 (1970). (In Serbo-Croatian).

Molybdenum (0.5 to 20 nM) is determined by its catalysis of the reaction between H_2O_2 and I^- in acidic medium at 20°. To a mixture of 0.01N KI, 2N HCl, and 0.2% starch solution, varying amounts of standard $(NH_4)_6Mo_7O_{24}$ solution and 0.01M H_2O_2 are added. The photocurrent is measured in a colorimeter against a blank. The resulting S-shaped curve has an induction period (t) that varies with Mo concentration, e.g., 5 min and 10 min with 10 and 1 ng of Mo per ml, respectively. The reciprocal of t (or the slope of the subsequent rectilinear portion of the curve) is plotted against Mo concentration to provide a calibration graph. The errors in determining 10 ng and 0.5 ng of Mo per ml were ±6% and ±10%, respectively. Lead (10 to 100 μM) can be determined indirectly by precipitation as $PbMoO_4$ and determination of unconsumed $Mo_7O_{24}^{6-}$ as described above. The OH^- concentration can be determined by catalimetric titration. Titration with standard acid, in the presence of aqueous H_2O_2, KI, and $Mo_7O_{24}^{6-}$, gives no catalytic reaction until H^+ ions are present in excess. Similar procedures are described for titrating Sn(II) with aqueous H_2O_2 and vice versa, and for titrating mg amounts of Pd^{2+} or Ag^+ with I^-. In these examples the catalytic reaction does not begin until H_2O_2 or I^-, respectively, is present in excess over the species being titrated. (Anal. Abstr.)

30725 ANALYTICAL APPLICATIONS OF IRON AND MOLYBDENUM COMPLEXES OF 2,3-DIHYDROXYNAPHTHALENE. Steichen, Richard John. Lawrence, Kan.; Univ. of

Kansas (1971). 140p. University Microfilms Order No. 72-11,805.

Thesis.

The iron(III), iron(II), and molybdenum(VI) complexes of 2,3-dihydroxynaphthalene (DHN) were studied with regard to possible analytical applications. A procedure for the colorimetric determination of iron(II) and iron(III) in the presence of each other is outlined. Factors affecting the stability of the iron(II) in the sample, such as the method of pH adjustment and the effect of heating to dissolve the sample, were considered. A sensitive and rapid technique for the colorimetric determination of molybdenum with DHN was developed. The optimum conditions for the analysis were found to be pH 5 to 7 and a one hundred-fold excess of DHN. The iron(II)-DHN complex in alkaline solution was utilized as a quantitative homogeneous reducing agent for the determination of a wide range of aromatic and aliphatic nitro compounds. Various methods of introducing the iron(II) complex, the kinetics of the reaction, the pH, and the indicating electrode were factors which were considered in design of the procedure. A potentiometric titration technique was developed whereby the iron(II) complex is formed in solution by the addition of a stable ferrous sulfate solution to a deaerated alkaline solution of DHN. The iron(II) complex is then titrated with a solution of the sample to be reduced. Some of the advantages of this method over existing nitro group determinations are: more rapid titrations, larger potential breaks at the equivalence point, lack of interferences due to nitrite and nitrate ions, stable reagents, mild conditions, and the ability to determine both aliphatic and aromatic nitro compounds. (TSS) (Diss. Abstr. Int., B)

30726 SOME EMISSION SPECTROGRAPHIC TRACE ELEMENT DATA FOR REFERENCE SILICATE MATERIALS. Hofmeyr, P. K. (Univ. of Cape Town). Chem. Geol.; 9: No. 1, 23-8(Mar 1972).

Data for six trace elements (Sc, Co, Y, Yb, V, Be) are reported for 27 standard silicate rocks. A dc arc emission spectrographic method was utilized using G-1, W-1, and a series of artificial rocks as standards. Results are tabulated and a brief discussion of the data is given. (auth)

30727 CHROMATOGRAPHIC AND BIOLOGICAL ASPECTS OF INORGANIC MERCURY. Fishbein, Lawrence (Public Health Service, Research Triangle Park, N. C. Dept. of Health, Education and Welfare, Research Triangle Park, N. C.). Chromatogr. Rev.; 15: No. 2-3, 195-238(Dec 1971).

The major areas of utility and the ecological and biological significance of inorganic mercury are reviewed along with salient paper, thin-layer, gas, column and ion-exchange chromatographic techniques for the separation and identification of inorganic mercury from environmental and forensic sources. Elements from which mercury was separated include: Cs, Ce, Mo, Sc, Th, W, U, Y, Te, Ru, and Sr. (165 references) (M.C.G.)

30728 SEPARATION OF CESIUM AND RUBIDIUM BY REPEATED EXTRACTION WITH A NITROBENZENE SOLUTION OF AMMONIUM DIPICRYLAMINATE. Kyrs, M.; Benesova-Pacltova, M.; Kadlecova, L. (Nuclear Research Inst., Rez, Czech.). Radiochem. Radioanal. Lett.; 10: No. 1, 1-9(14 Apr 1972).

Suitable conditions for the mutual separation of weighable amounts of cesium and rubidium by multi-stage extraction with ammonium dipicrylaminate in nitrobenzene were investigated. Separation was performed in the presence of ammonium carbonate or chloride by repeated extraction with organic phase transfer. The effective separation factor for cesium—rubidium is 5.3. Admissible initial alkali metal concentrations are 0.02 mol/l or lower. The procedure was used in combination with a concentration dependent distribution method for the determination of 6 to 150 μg of cesium in about 3 mg of rubidium using ^{137}Cs for isotope dilution. (auth)

30729 BENZOYL-m-NITROACETANILIDE AS A GRAVIMETRIC REAGENT FOR URANIUM(VI). Chaudhuri, Nirmalkusum; Das, Jyotrimoy (Univ. of Burdwan, India). Indian J. Chem.; 9: No. 12, 1398-400(Dec 1971).

Uranium(VI) was quantitatively precipitated with benzoyl-m-nitroacetanilide by adjusting the pH in three different ways. Adjusting the pH to 5.8 or above with pyridine affords a vermilion red complex, $UO_2(C_{15}H_{11}O_4N_2)_2 \cdot 2H_2O$. The precipitate is formed homogeneously in the presence of Mg-EDTA or sulfosalicylic acid. From solutions of pH 6.8 to 7.8 buffered with ammonium acetate-ammonia, another red complex, $UO_2(C_{15}H_{11}O_4N_2)_2 \cdot NH_3 \cdot H_2O$, is precipitated. The third complex is obtained homogeneously when the pH is raised with boiling urea solution. Using Mg-EDTA, sulfosalicylic acid, or iodide ions as masking agents separation of uranium(VI) from Pb^{2+}, Ni^{2+}, Be^{2+}, Hg^{2+}, Al^{3+}, Cr^{3+}, Fe^{3+}, Ce^{3+}, Th^{4+}, Zr^{4+} or VO^{2+} is possible. The relative standard deviation is ±0.24%. (auth)

30730 PHOTOMETRIC AND GRAVIMETRIC DETERMINATION OF RUTHENIUM AND OSMIUM WITH THE USE OF CRYSTAL VIOLET. Pilipenko, A. T.; Ol'khovich, P. F.; Bondarenko, V. Yu. (Inst. of General and Inorganic Chemistry, Kiev). Ukr. Khim. Zh.; 37: No. 12, 1269-73(Dec 1971). (In Russian).

The conditions for precipitating ternary complexes of Ru and Os using Crystal Violet and thiocyanate ions were established by a photometric method. The relative error for Ru determination photometrically was ±10%. A gravimetric method was based on weighing the vacuum-dried complex $(C_{25}H_{30}N_3)_3[Ru(NCS)_6]$ as precipitated at a pH of 1. The platinum metals interfere. Conditions are described for the corresponding gravimetric method for Os by weighing the complex $(C_{25}H_{30}N_3)_2[Os(NCS)_4]$. (K.S.W.)

30731 SCANDIUM EXTRACTION IN THE FORM OF AN IONIC ASSOCIATE WITH 2-PHENYLQUINOLINE-4-CARBOXYLIC ACID AND RHODAMINE C. Bel'tyukova, S. V.; Poluektov, N. S. (Inst. of General and Inorganic Chemistry, Odessa). Ukr. Khim. Zh.; 37: No. 12, 1277-9(Dec 1971). (In Russian).

Scandium ions form ionic associates with 2-phenylquinoline-4-carboxylic acid and Rhodamine C that may be extracted with benzene or other organic solvents. Other agents were also tried in the place of Rhodamine C: Malachite Green, Brilliant Green, Methyl Blue, Crystal Violet, etc. Measurement of the optical density of the extract at 556 nm is the basis for the Sc determination. A number of elements interfere: rare earths, Th, Al, Fe, Ga, In, Zr, Hf, Ti, and Bi. (K.S.W.)

Radiometric and Radiochemical Procedures

Refer also to abstracts 30645, 31074, and 31166.

30732 (DP-1291) IMPROVED METHODS FOR DETERMINATION OF ^{236}Pu IN ^{238}Pu. Banick, Cyril J.; Goosey, Malcolm H. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Mar 1972. Contract AT(07-2)-1. 21p. Dep. NTIS.

The precision and accuracy of two methods for determining ^{236}Pu in ^{238}Pu were improved significantly. A pulse pileup rejector (PPR) was used with the direct alpha pulse height analysis (APHA) to determine 0.1 to 1.3 ppM ^{236}Pu in submicrogram samples. For a sample containing <0.2 ppM ^{236}Pu, the direct APHA method can be used only to estimate an upper concentration limit. The addition of a PPR allows higher count rates for shorter times without interference from pileup of ^{238}Pu pulses into the energy channels of the ^{236}Pu pulses. Special ion exchange purification was used with the uranium daughter method to determine ^{236}Pu concentrations as low as 4 ppB. The average precision by direct APHA and by the uranium daughter method was ±5% at the 90% confidence level. (auth)

30733 (KFK-1429) ANNUAL REPORT, 1970. FISSION PRODUCT CONTROL PROJECT. (Kernforschungszentrum, Karlsruhe (West Germany)). Sep 1971. 191p. (In German). Dep. NTIS (U. S. Sales Only).

Optimization methods for establishment of the inspection costs for an isolated nuclear installation were developed. Some quantitative results obtained are tabulated and graphed. A simulation method was developed for the fuel flow in a reprocessing plant. The material balance in the various units of the plant is given as a function of the time for a normal operation. From a detailed analysis of the Karlsruhe reprocessing plant, design criteria were developed for future reprocessing plants. Studies on the problem of initial measurements in a reprocessing plant showed a series of adulteration possibilities of the initial material inventory existing in present plants. Studies on integral safeguards in a reprocessing plant were focused on the determination of the physical fission inventory, identification of irradiated fuel elements, and isotope correlations. The development of optimum monitoring safeguards, undertaken in cooperation with industry, is briefly outlined. Nondestructive methods for use in fuel cycles were studied and developed. A triple chopper apparatus was constructed for the measurement of delayed γ radiation in the millisecond range. A systematic comparison was made of the γ spectra of ^{235}U and ^{239}Pu after irradiation with slow neutrons. The γ spectrum of ^{239}Pu from neutron capture was measured with a coincidence—anticoincidence device. The use of the measurement of the radiation of daughter nuclides for the determination of ^{239}Pu, ^{241}Pu, ^{235}U, and ^{238}U was investigated. An Sb—Be neutron source was developed, which produces sufficiently intense beams or fields of neutrons with energy high enough to provide good transparency but low enough not to fission breeder material and which differentiates between primary and secondary neutrons. Typical results obtained with this source for determination of ^{235}U are tabulated. The results obtained on the use of reactivity measurements for the quantitative determination of fissionable material in U, Pu, and mixed fuel rods with various enrichments and Pu content are reported. The application of the delayed neutron method to the waste measurements of ^{235}U and Pu was investigated and the factors affecting the measurement were determined. The dependence of the measurement signal on the position of the sample within the waste packet, the reproducibility, and the accuracy of Pu absolute determinations was determined in the use of passive methods for the determination of Pu in scraps and waste. A double-difference calorimeter for determination of Pu was developed. A slowing-down-time spectrometer was developed for the determination of fissionable material. A γ lock for personnel and material control of Pu was developed. Analysis methods used in the Mol II and Mol III experiments were outlined. Automation of the mass spectrometric isotope dilution analysis, and of the uranium and plutonium concentration determinations by x-ray fluorescence was developed. The principles for the automation of the emission spectrometric isotope determination in nuclear fuels were determined. (J.S.R.)

30734 (N–72–14142) USE OF RADIATION IN PREPARATIVE CHEMISTRY. Philipp, W. H.; Marksik, S. J.; May, C. E.; Lad, R. A. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec 1971. 19p. (NASA-TM-X–67982; E–6706). NTIS.

A summary and updating of previous work on the use of radiation chemistry for the preparation of pure materials are presented. Work was chiefly concerned with the reduction of metal salts in solution to the free metal using 2-MeV electrons. Metals deposited from aqueous solution are copper, silver, zinc, cadmium, thallium, tin, lead, antimony, iron, nickel, cobalt, and palladium. Dry organic solvents were evaluated for the deposition of metals based on a study involving deposition of antimony from solutions of antimony(III) chloride. The use of organic liquids for the preparation of anhydrous metal halides is also presented. Reaction mechanisms for both organic liquids and aqueous system are discussed. (STAR)

30735 (SGAE-CH–76/1971) ANALYSIS OF IRRADIATED FUEL FOR ACTINIDES AND DETERMINATION OF BURN UP. Muellner, P.; Pfeifer, V.; Falta, G. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). Nov 1971. 17p. (CONF-711107–12). Dep. NTIS (U. S. Sales Only).

From Symposium on analytical methods in the nuclear fuel cycle; Vienna, Austria (29 Nov 1971).

A set of experimental techniques for the determination of uranium and plutonium in highly burned fuel samples was tested and developed up to a routine method. The determination of burnup was performed by destructive as well as by nondestructive methods. A good compromise was achieved between accuracy, instrumentation, manpower, and flexibility for a large variety of fuels. For the chemical analysis some established methods are combined with slight modifications. In the case of ceramic fuels, head–end treatment and first decontamination are achieved simultaneously by thermal chlorination or anion exchange methods. Further purification can be performed by conventional analytical techniques (anion exchange in chloride medium or liquid–liquid extraction with tri-n-octylphosphine oxide from nitrate solutions). A semiquantitative separation is used for isotope dilution mass spectrometric analysis of the actinides as well as for mass spectrometric burnup determination. Nondestructive burnup data are obtained from the total number of fissions in certain fuel samples, as determined by direct measurement of radioactive fission products using Ge(Li) spectrometry. (auth)

30736 (SZS–19/71 (pp 1-12)) RADIOCHEMICAL DETERMINATION OF ^{210}Pb IN BIOLOGICAL SAMPLES. Naumann, M.; Zimmerschied, K. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (In German). Dep. NTIS (U. S. Sales Only).

A method is described for determination of ^{210}Pb in urine, ashed feces, hair, and bone meal. After treatment with $H_2O_2-Fe^{2+}$ the daughter nuclide ^{210}Bi is plated on a nickel disk, which is counted for the beta activity of the deposited ^{210}Bi. The method is used for routine determination of ^{210}Pb in urine and feces. (auth)

30737 (SZS–19/71 (pp 13-20)) ASSESSMENT OF AIRBORNE ^{203}Hg. Rehak, W.; Ubl, G. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (In German). Dep. NTIS (U. S. Sales Only).

A method is described for the determination of airborne compounds of ^{203}Hg. The method is based on the sorption of Hg on hopcalite (activated copper oxide–manganese oxide) with subsequent monitoring for the gamma radiation of ^{203}Hg. The sensitivity of the method permits assessment of less than one tenth of the maximum permissible concentration in air. It is shown that the separation procedure used is suitable for mercuric acetate and its thermal decomposition products. (auth)

30738 (UCRL–51061(Vol.2)) COMPUTERIZED QUANTITATIVE ANALYSIS BY GAMMA-RAY SPECTROMETRY. VOL. II. SOURCE LISTING OF THE GAMANAL PROGRAM. Gunnink, R.; Niday, J. B. (California Univ., Livermore. Lawrence Livermore Lab.). 6 Dec 1971. Contract W-7405-eng-48. 207p. Dep. NTIS.

This volume is the source listing of the GAMANAL program, written in LRLTRAN, an extended FORTRAN language. GAMANAL provides a complete qualitative and quantitative analysis of mixtures of radioactive species by computer interpretation of their gamma spectra. (auth)

30739 STUDY OF MICROESTIMATION OF SILVER AND IODIDE BY RADIOMETRIC PROCEDURE WITH ^{131}I IN PRESENCE OF OTHER INSOLUBLE IODIDES. Purkayastha, U.; Maity, H. P. (SINP, Calcutta). Indian J. Appl. Chem.; 31: No. 5-6, 181-4(1968).

Micro estimation of Ag and I using ^{131}I as a measuring indicator was studied. Excess I (double or triple the theoretically equivalent amount of the metal) as KI ^{131}I was added to the unknown metal in acid solution and the trace of metal iodide is carried along with $Zr_3(PO_4)_2$. From the loss in activity of ^{131}I in the solution the amount of the metal can be estimated. If Ag is known, unknown iodide can be computed. Ag or iodide ranging from (about 4×10^{-3} to 1×10^{-6}) g has thus far been estimated with a fair degree of accuracy. The estimation is possible in the presence of some insoluble iodides. The method is simple and does not take more than 30 min. (Ind. Sci. Abstr.)

30740 GAS ANALYSIS OF TRITIUM IN THE FORM OF ETHANE. Seliga, M.; Povinec, P.; Chudy, M. (Komensky Univ., Bratislava). Collect. Czech. Chem. Commun.; 37: No. 2, 448-52(Feb 1972).

A procedure for the determination of extremely low concentrations of tritium in atmospheric humidity is described, consisting in hydrogenation of acetylene to ethane. Hydrogen is prepared by reduction of tritium oxide contained in air humidity. (auth)

30741 IN-LINE ANALYTICAL METHODS FOR FUEL PROCESSING STREAMS. PART II. GAMMA ABSORPTIOMETRY FOR URANIUM. Bhargava, V. K.; Chandrasekharan, E. S.; Iyer, R. H.; (and others) (Bhabha Atomic Research Centre, Trombay, India). pp 331-8 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.2).

As part of a program of development work on in-line monitoring systems for the continuous assay of uranium, plutonium, and fission products in the fuel reprocessing plant, a gamma absorptiometer was built and tested. The instrument consists of a 50-millicurie ^{241}Am gamma source, a stainless steel flow cell with teflon windows, a thin NaI(Tl) crystal, and an electrical readout system. By use of this equipment uranium could be determined in the 10- to 350-g per liter range with an accuracy of ±5 to 8% at lower concentrations (<25 g/l) and ±2.5% at high concentrations. The mass absorption coefficient for uranium was found to be 7.6 cm^2/gm. Mass absorption coefficients for some principal light element constituents like H_2O, HNO_3, NO_3, $Al(NO_3)_3$, Al, TBP and ferrous sulfamate were determined to evaluate the extent of their interference. Interference due to gross fission products was by far the largest but it can be compensated by taking the measurement twice, once with the ^{241}Am source and once without it. It was found that with the present set-up activities of the order of 100 millicurie per liter would cause an error of about 10% in the uranium analysis. (auth)

30742 RADIOCHEMICAL ANALYSIS OF ^{111}Ag, ^{99}Mo, AND ^{125}Sn IN FALLOUT DUST SAMPLES AND ITS APPLICATION IN FINDING OUT THE TYPE OF FISSILE MATERIAL USED IN A NUCLEAR EXPLOSION. Anand, S. J. S.; Subba Rao, M. (Bhabha Atomic Research Centre, Trombay, India). pp 339-46 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

A radiochemical procedure used for determination of silver-111, molybdenum-99, and tin-125 from fresh fallout dust samples is described. The procedure used is short and quantitative and the separated isotopes are free from contamination of other fission products. Accurate measurements of these isotopes and their activity ratios provide valuable information regarding the type of fissile material used in a nuclear explosion. (auth)

30743 ESTIMATION OF ^{237}U AND ^{239}Np IN FALLOUT DUST SAMPLES AND ITS APPLICATION FOR IDENTIFICATION OF THERMONUCLEAR REACTION IN A NUCLEAR EXPLOSION. Khandekar, R. N.; Santani, S. B.; Subba Rao, M. (Bhabha Atomic Research Centre, Trombay, India). pp 347-53 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.2).

The radiochemical procedure used for estimation of uranium-237 and neptunium-239 from fallout dust samples collected at high altitudes is described. The analytical procedure used is rapid and gives a clean separation of uranium and neptunium from fission products. The production of uranium-237 and neptunium-239 compared to other fission products gives information about the mode of thermonuclear reaction having taken place in a nuclear explosion. (auth)

30744 MEASUREMENT OF ^{32}P LABELLED PHOSPHOLIPIDS IN LIQUID SCINTILLATION COUNTER WITHOUT ADDED SCINTILLATOR. Satyaswaroop, P. G. (Bhabha Atomic Research Centre, Bombay). pp 389-95 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.2).

Cherenkov radiation produced by ^{32}P in both aqueous and organic solvents was determined using conventional liquid scintillation counters. A simple, convenient, and highly efficient method for counting ^{32}P-labeled phospholipids in biological materials was developed based on this principle. Using biosynthetically prepared ^{32}P-labeled phospholipids, the currently employed counting procedure and the new method of measuring ^{32}P without added scintillators in organic solvents, toluene and methanol, were compared. Stimulation of ^{32}P incorporation into phospholipids of bovine thyroid slices by TSH was studied using the conventional liquid scintillation counting procedure and the newly developed counting method. The phospholipids separated on thin layers of silica gel were also counted as such (dry without adding any solvents) in glass vials with efficiency of 10%. The counting efficiency could be increased up to six-fold by counting this silica gel scrapings as a homogeneous suspension with thyxotropic gel in toluene. The advantages and applicability of this method are discussed. (auth)

30745 MOESSBAUER SPECTROMETRY. Stevens, John G. (Univ. of North Carolina, Asheville); Travis, John C.; DeVoe, James R. Anal. Chem.; 44: No. 5, 384R-406R(Apr 1972).

Chemical applications of Moessbauer spectroscopy are reviewed. Nuclear parameters for observed Moessbauer transitions and chemical applications of ^{57}Fe, ^{119}Sn, and other isotopes in Moessbauer spectrometry (1970–1971) are listed. Instrumentation and experimental techniques, recent developments, practical theory, and structure and bonding are discussed. (771 references). (M.C.G.)

30746 RADIOCHEMICAL METHODS IN FISSION YIELD DETERMINATIONS. von Gunten, H. R. (Univ., Bern). pp 7-11 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

A review is given of absolute and relative fission yield determinations by radiochemical methods. Classical methods using normal and fast procedures for the chemical separation of elements as well as instrumental methods are described. Special emphasis is given to the possibilities of the use of fast on-line techniques for fission yield determinations. (34 references) (auth)

30747 ABSOLUTE DETERMINATION OF RADIONUCLIDES IN WATER BY γ-SPECTROMETRY. Mundschenk, H. (Bundesanstalt fuer Gewaesserkunde, Coblenz). Deut. Gewaesserk. Mitt.; 15: No. 4, 95-105(1971). (In German).

Absolute counting of radionuclides in river water can be effected by using a calibrated scintillation detector. The determination of single radionuclides is performed without any chemical separation. The sensitivity of this method is far beyond the critical values listed in the "Strahlenschutzverordnung" (Radiation Protection Ordinance) of the Federal Republic of Germany. Decomposition of overlapping photopeaks is achieved by means of suitable methods described in detail. (INIS)

30748 URANIUM CONCENTRATIONS IN MARINE SEDIMENTS. Mo, Maung Tin. College Station, Tex.; Texas A and M Univ. (1971). 163p. University Microfilms Order No. 72-13,238.

Thesis.

A critical study was made to determine the optimum conditions for assaying uranium in marine sediments by delayed neutron counting after thermal neutron fission of ^{235}U. The fast, simple precise, sensitive and nondestructive method was applied to measure uranium concentrations in sediments deposited under varying conditions. The world-wide spatial distribution of uranium concentrations in a large number of samples of marine sediments of different types was studied. Several interesting relationships were observed. (1) There is an approximately proportional trend between percent organic carbon and uranium in sediments deposited in an anoxic environment—7% organic carbon and 7 ppM uranium to 14% organic carbon and 30 ppM uranium. (2) For manganese nodules an approximately linear trend is indicated between uranium and calcium concentrations with both decreasing with increasing depth of deposition—for nodules from the Pacific, 4 ppM uranium with 0.2% calcium, found at 4500 meters and 13 ppM uranium with 1.2% calcium, found at 1000 meters; for nodules from the Atlantic 13 ppM uranium with 14% calcium, found at 494 meters and 7 ppM uranium with 0.2% calcium found at 1029 meters. (3) Relatively high uranium was found in carbonates deposited in: (a) the deepest parts of the Gulf of Mexico—up to 2.7 ppM in microgastropods and about 0.4 ppM in foraminifera, up to 5.75 ppM in Campeche Bank carbonates and 2.57 ppM in the Yucatan Shelf carbonates; (b) the Florida Shelf area—2.22 to 4.77 ppM in skeletal sands containing 76 to 61% calcium carbonate respectively; (c) the Atlantic Ocean—2.68 to 4.28 ppM uranium in the Barbados corals and about 0.57 ppM uranium in cores which have about 86% calcium carbonate; (d) the Pacific Ocean—about 0.63 ppM in cores which have about 86% calcium carbonate; (e) the Red Sea—up to 5.94 ppM uranium in the skeletal sands. These findings seem to invalidate the usual practice of expressing uranium data on a calcium carbonate free basis in which it is assumed that the calcium carbonate fraction has negligible uranium. (Diss. Abstr. Int., B)

30749 COMPARISON OF RADIOCHEMICAL METHODS FOR ^{137}Cs DETERMINATION. Okashita, Hiroshi; Natsume, Haruo (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 4, 241-8(Apr 1972).

Results are presented of a comparative study seeking an accurate and precise radiochemical method for ^{137}Cs determination in burnup measurements. The methods taken up are chloroplatinate precipitation (Method I), tetraphenylborate precipitation (Method II), tetraphenylborate extraction (Method III), potassium hexacyanocobalt (II) ferrate (II) substitution (Method IV), and ion exchange (Method V). A common sample, an aqueous solution obtained from dissolving irradiated uranium fuel and containing approximately 5μCi of ^{137}Cs, was analyzed by seven analysts using the five methods. A statistical analysis of the results obtained (105 values in all) shows that the expected precision, at the 0.05 probability level, of a single determination in non-rehearsed trials of each method is: Method I, ±3.0%; Method II, ±5.6%; Method III, ±5.3%; Method IV, ±10.9%; Method V, ±4.2%. The accuracy follows the same pattern except Method III and Method IV. The advantages and disadvantages of the five methods are discussed from the standpoint of utilization in burnup measurements. (auth)

30750 TRITIATED WATER IN TRITIUM ACTIVIATED LUMINOUS DEVICES. Guthrie, D. G.; Coates, J. A. (Saunders-Roe Dev. Ltd., Middlesex, Eng.). Health Phys.; 22: No. 5, 522-3(May 1972).

Samples containing 8 to 2000 mCi of tritium, with an average content of 500 mCi, were taken from the contents of gaseous tritium-activated lights. In approximately 30 mass spectrometric determinations, the quantity of HTO/T_2O did not exceed the estimated limit of detection of about 0.1% of the original quantity of tritium. The differences are discussed between these and the results of Knapton and Comer [Health Phys. 20, 345 (1971)] from samples obtained of ~4mCi, whose tritiated water was measured by trapping it in water bubblers and cold traps. (UK)

30751 FEASIBILITY OF IMPROVING THE SENSITIVITY OF THE DOUBLE-FILTER METHOD FOR MEASURING RADON AND THORON IN AIR. Paskalev, Z. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 37-43(1967).

The experimental arrangement for separate determination of Rn and ^{220}Rn in exhaled breath is described. The method is a modification of the two-filter method and its sensitivity is 2.1×10^{-14} Ci/l. (M.C.G.)

30752 METHOD FOR DETERMINING RADON CONTENT OF WATER BY MEASURING BETA–GAMMA RADIATION WITH A SCINTILLATION COINCIDENCE ARRANGEMENT. Paskalev, Z. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 33-6(1967).

This method provides rapid information from small amounts of water. Sensitivity of the method is 9×10^{-9} Ci/l. Only radon waters, clear and uncontaminated by other radioisotopes (above MPC), may be investigated by the method proposed. (M.C.G.)

Separation Procedures

Refer also to abstracts 30782, 30884, 30901, and 31135.

30753 (AAEC/TM-610) ANION ENHANCEMENT OF THE EXTRACTION OF ZIRCONIUM BY ALIQUAT-336 FROM CHLORIDE MEDIA. Macdermott, T. E.; Pearson, J. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jan 1972. 20p. Dep. NTIS (U. S. Sales Only).

In aqueous chloride media above 2M acid, the extraction of zirconium ions by Aliquat-336 depends solely on the total chloride ion concentration and is independent of the hydrogen ion or lithium ion concentration. For total chloride ion concentrations between 6 and 8M, the addition of small amounts of nitrate ion greatly enhances the extraction of zirconium by Aliquat-336. This enhancement is a maximum at between 0.5 and 0.75M nitrate ion in the aqueous phase. This effect is also independent of hydrogen ion or lithium ion concentration. It is postulated that the species being extracted is $[ZrCl_5NO_3]^{2-}$. These results are preliminary to selecting the optimum conditions for the extraction of zirconium, and also for the separation of zirconium from hafnium by a liquid anion exchange process. (auth)

30754 SEPARATION OF CURIUM–CALIFORNIUM BY EXTRACTION CHROMATOGRAPHY. Aly, H. F.; Abdel-Rassoul, A. A. (Atomic Energy Establishment, Cairo). Z. Anorg. Allg. Chem.; 387: No. 2, 252-8(Jan 1972).

Sequential separation of the trivalent actinides Cm and Cf is investigated by extraction chromatography using the system Alamine 336–LiCl on the diatomaceous earth, Celite 360. The effect of the mobile phase concentration and the acidity on the distribution behavior of both elements is found almost to parallel that based on simple liquid–liquid extraction. Optimum resolution and efficient decontamination is readily achieved by 11 M LiCl in 0.02 M HCl. The possible use of the same system for the decontamination of the +3 actinides from various foreign ions is also pointed out. (auth)

30755 SEPARATION OF ARSENIC(III), MOLYBDENUM(VI), ANTIMONY(III), AND TIN(IV) BY THIN-LAYER CHROMATOGRAPHY. Aliotta, G.; de Silvetti, D. P. (Univ. Nacional del Sur, Bahia Blanca, Argentina). An. Asoc. Quim. Argent.; 59: No. 2, 63-7(1971). (In Spanish).

The separation of these species by thin-layer chromatography on silica gel with the use of mixtures of HCl with various alcohols as solvents (ascending) was studied. The best separations were obtained with ethanol–4N HCl (9: 1), propanol–4N HCl (9: 1), or butanol–4N HCl (9: 1), the respective R_F values in these solvents being 0.20, 0.19, and 0.27 (As); 0.56, 0.52, and 0.50 (Mo); 0.77, 0.76, and 0.75 (Sb); and 0.81, 0.80, and 0.78 (Sn). (Anal. Abstr.)

30756 SEPARATION OF RHENIUM AND MOLYBDENUM BY EXTRACTION USING ANTIPYRINE ORANGE. Vasil'ev, V. P.; Kashirina, F. D.; Khranina, E. N. (Ivanovo Chemical Tech. Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 15: No. 1, 32-4(1972). (In Russian).

The effects of concentration and other factors on the completeness of extraction of rhenium and molybdenum by aqueous solutions of the dye Antipyrine Orange were investigated. Concentrations of Re as low as 0.50 mg/l could be 80 to 90% extracted at one time with $CHCl_3$ in the presence of 1 mole H_2SO_4/liter in the aqueous phase, even in the presence of 100 times as much Mo. (K.S.W.)

30757 EXTRACTION OF TELLURIUM(IV) FROM SULPHURIC ACID AND POTASSIUM IODIDE CONTAINING SOLUTIONS. Havezov, I.; Stoeppler, M. (Kernforschungsanlage, Juelich, Ger.). Z. Anal. Chem.; 258: No. 3, 189-92(1972). (In German).

o-Xylene and other nonpolar solvents extract the neutral and nonpolar tellurium tetraiodide. Acetophenone (A) extracts this compound as $TeI_4 \cdot 3A$. Tellurium tetraiodide polymerizes in the aqueous phase at tellurium concentrations $\geq 10^{-5}$ M. (auth)

30758 EXCHANGE BEHAVIOUR OF TIN, ANTIMONY, AND URANIUM IN AQUEOUS/NONAQUEOUS MEDIA ON THE CATION-EXCHANGER ZIRCONIUM PHOSPHATE. Marei, S. A.; Aly, H. F.; Zakareia, N. (Atomic Energy Establishment, Cairo). Z. Anal. Chem.; 258: No. 4, 282-3(1972).

The distribution coefficients of antimony, tin, and uranium from HCl solutions are given. The effect of organic solvent addition on the exchange behavior of the cations was investigated. (M.C.G.)

30759 SEPARATION OF MOLYBDENUM AND RHENIUM IN SOLUTION BY ION EXCHANGE. Zagorodnyaya, A. N.; Lebedev, K. B.; Ponomarev, V. D. Tr. Inst. Met. Obogashch., Akad. Nauk Kaz. SSR; 40: 91-6(1970). (In Russian).

The sorption of Mo and Re, present together, by some commercial resins was studied. With weakly basic ion-exchange resins, maximum adsorption of Mo and Re occurred in the pH range 3 to 7, but, with moderately or strongly basic resins, the pH range of adsorption was wider and displaced towards the alkaline region. The greatest differences in the extent of adsorption of Mo and Re were observed on the anion-exchange resins AN-21, AN-20, AN-22, and AN-18 in acid media; the Cl^- form of each resin gave the best retention of Re. Increasing the concentration of one metal led to impaired recovery of the other. Resin AN-21X8 can be used to separate Mo and Re in an acid medium; Re is adsorbed but Mo remains in solution. (Referativnyi Zh.)

30760 ADSORPTION BY STRONGLY IGNITED ALUMINA OF IODIDE AND SULPHATE IONS AT TRACER CONCENTRATIONS: VARIATION WITH pH OF THE MEDIUM. Tripathi, P. S. M.; Prasad, B. B. (Banaras Hindu Univ., India). pp 179-87 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

The adsorption of these ions by alumina was studied using ^{131}I and ^{32}P as tracers, with a view to understand the time-rate growth of the uptake and its dependence on pH of the medium. The pH was varied over a wide range, i.e., 1 to 11, using for adjustment, HCl and K_2CO_3 in the low and high regions, respectively. Both the rate and the net amount of adsorption were greatly affected by pH. Adsorption increased initially in the highly acidic solutions to a maximum and then, with further increase in pH, decreased continuously. The pH value for maximum adsorption was determined, for such anions, to lie in the acidic region of 3.5 to 4.5. The importance of this observation, representing true adsorption uninfluenced by electrical field, was utilized in subsequent studies. The results were interpreted, making use of the ζ-potential of the surface and the ion exchange processes. (auth)

30761 PROGRESS IN SEPARATION AND PURIFICATION. VOLUME 4. Perry, Edmond S.; Van Oss, Carel J. (eds.). New York; John Wiley and Sons, Inc. (1971). 422p.

A separate abstract was prepared for one of the eight chapters presented. The other chapters include: permeability as a phenomenological coefficient; continuous column crystallization; endless belt electrophoresis; hydrocarbon separations with silver(I) systems; parametric pumping; continuous sample flow; density gradient centrifugation; and continuous chromatographic refining. (D.H.M.)

For an abstract of an individual chapter see: 30762.

30762 USE OF LIQUID ANION-EXCHANGERS IN REVERSED-PHASE EXTRACTION CHROMATOGRAPHY. Brinkman, U. A. Th. (Free Reformed Univ., Amsterdam). Progr. Separ. Purif.; 4: 241-96(1971).

The application of liquid anion exchangers to inorganic analysis is reviewed to early 1970, including materials; methods; thin-layer and paper chromatographic results (sorption sequence, chloride systems, other halogenide systems, thiocyanate systems, nitrate systems, and miscellaneous); separation on paper and thin layers (qualitative analysis and quantitative analysis); column chromatography (transition metals, actinides and lanthanides, and miscellaneous); and theoretical aspects (chromatography and liquid–liquid extraction, liquid and resin exchangers, and mechanism of the process). (130 references) (D.H.M.)

30763 ION EXCHANGE MEMBRANE PROCESS TO CONCENTRATE URANYL IONS. Wu, James Shiou-hwa. Columbia, S. C.; Univ. of South Carolina (1969). 116p. University Microfilms Order No. 72-12,034.

Thesis.

Studies of the Donnan equilibrium principle to develop a continuous membrane process for concentrating heavy metal ions, such as UO_2^{2+}, Pu^{3++}, etc., by the use of the flat cation ion exchange membranes were made. Several multiple-thin-channel membrane concentrators were designed and fabricated using AMF* C-103 cation exchange membranes. Specifically, a system for the concentration of UO_2^{2+} ions from dilute solutions of uranyl nitrate was designed and tested. Nitric acid was used as the extractive strip solution. Experimental studies of the process variables under different flow regimes and acid strengths were made to find optimum operating conditions for the concentration. The average uranyl flux, anion leakage and osmosis are presented for different membrane concentrators and operating conditions. A process was developed that suppresses the inherent osmotic flux to a minimum by converting the membrane into mainly the metal ion form. A concentration factor of more than 30 times has been achieved with a loss of less than 4% of the original uranyl ions in the feed. An economic single stage, multiple-pass membrane concentrator with recycling of the extractor stream is proposed as the final design. In parallel with the experimental studies, a theoretical approach was made to study the ionic transport through ion exchange membranes. The mathematical model was established from the non-linear Nernst–Planck equations of ionic motion, which take into account the effect of both the chemical and electric potentials within the system. The sets of governing differential equations were solved with appropriate boundary conditions, in terms of specific numerical methods by a digital computer simulation of the model. The concentration profiles of various ions and the electric potential profile were found for the membrane layer and both film layers adjacent to the membrane. The flux of the different ionic species and anion leakage can also be predicted from the model for given bulk concentrations. The relationship of ionic flux to the change of ionic concentration was found. The numerical results as well as plots of the results are presented. (Diss. Abstr. Int., B)

30764 GIDROMETALLURGIYA. IZBRANNYE TRUDY I. N. PLAKSIN. (Hydrometallurgy. Selected Works of I. N. Plaksin). Ivanovskii, M. D. (ed.). Moscow; Izdatel'stvo Nauka (1972). 279p.

This collection of 31 papers by I. N. Plaskin is concerned with the theory and technology of extracting precious metals by hydrometallurgical processes. The emphasis is on gold, silver, and the platinum metals, and the papers are grouped as to process, i.e., amalgamation, leaching, ion exchange, and extraction. Two papers from the last group deal with the extraction of rare earth elements; the effect of diluents on their extraction by C_7 to C_9 carboxylic acids was studied, with the result that the diluents studied were placed in the following order as to their effect on the extractive equilibrium: heptyl alcohol > decyl alcohol > isoamyl acetate > meta-xylene > bis(chloroethyl) ether > CCl_4 > kerosene. The second paper discusses rare earth extraction using TBP, and a processing scheme is recommended that is capable of a high quality product. A 50% HNO_3 is utilized at 90°C to dissolve up to 95% of the rare earth values. Multistage countercurrent extraction with TBP permits a separation from Ca and Fe, and recovery of 94 to 98% of the remaining rare earths. (K.S.W.)

30765 ADSORPTION OF MONOVALENT IONS ON ZINC FERROCYANIDE. Ganzerli-Valentini, M. T.; Meloni, S.; Maxia, V. (Univ., Pavia, Italy). J. Inorg. Nucl. Chem.; 34: No. 4, 1427-36(Apr 1972).

The adsorption from different solutions of cesium, rubidium, potassium, sodium, lithium, silver and mercury (I) on zinc ferrocyanide was studied. The preparation of the adsorber and its characterization are presented and discussed. The sorption of the alkali metals appears to proceed by an ion-exchange mechanism in NH_4NO_3 solutions. In HNO_3 solutions oxidation to zinc ferricyanide and the destruction of the adsorbed species influence the behavior of the cations. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 30854 and 31448.

30766 TRANSITION ELEMENTS. Cross, R. J.; Winfield, J. M. (Univ. of Glasgow). Annu. Rep. Progr. Chem., Sect. A; 67: 341-90(1970).

This review contains sections on the recent chemistry of the rare earths, the actinides (including elements 104 and 105), zirconium and hafnium, niobium and tantalum, and technetium. (420 references) (UK)

Chemical and Physical-Chemical Properties

Refer also to abstracts 30666, 30745, 30871, 30916, 31299, 31301, and 32727.

30767 TRITIUM IN DEUTERATED COMPOUNDS. Leete, E.; Chedekel, M. R. (Univ. of Minnesota, Minneapolis). Nature (London); 236: No. 5343, 166-7(24 Mar 1972).

It is stated that most users of deuterium compounds seem to be unaware of the presence of T in these compounds, often in amounts that require a licence for possession. Also those using T as a tracer should be aware of the potential contamination with D. The T content of several commercial D compounds was measured and results are shown tabulated. (UK)

30768 STRUCTURE OF THE SUPPORTED URANIUM OXIDE CATALYST AND CATALYTIC ACTIVITY FOR OXIDATION OF CARBON MONOXIDE. Nozaki, Fumio; Kobayashi, Masayuki; Yoshida, Setsuko (Chiba Univ., Japan). Nippon Kagaku Kaishi; No. 1, 26-33(Jan 1972). (In Japanese).

In order to reveal the catalytic properties of uranium oxide–alumina and uranium oxide–silica, various investigations on the structure of the catalyst and kinetics of the catalytic oxidation of CO were performed. It was found that the oxidative activity of the catalyst supported on silica is remarkably low, compared to the catalyst supported on alumina. The reaction rates of CO oxidation by the catalyst supported on alumina or the catalyst without carrier can be expressed approximately as the first order with CO pressure and the zeroth order with O_2 pressure. Apparent activation energy is approximately 25 kcal/mole for the former catalyst and 18 kcal/mole for the latter catalyst. The following reaction scheme has been postulated: $U_3O_8 + CO \rightarrow U_3O_7 + CO_2$ (catalyst reduction step) and $U_3O_7 + \frac{1}{2} O_2 \rightarrow U_3O_8$ (catalyst oxidation step). The reaction proceeds by oxidation–reduction cycles, in which the catalyst reduction step is the rate-determining process. In general alumina and silica tend to combine with uranium oxide or uranyl compounds during the course of catalyst preparation. The catalyst calcined up to 500°C contains various chemical species of uranium, of which the catalytic levels are different. It is evident that the active components are limited only to uranium oxide on alumina and uranium oxide–alumina compound. (auth)

30769 THERMAL BEHAVIOUR AND STRUCTURAL STUDIES OF TRIETHANOLAMINE COMPLEXES OF METALS. Rao, G. N.; Rustagi, S. C. (Indian Inst. of Tech., New Delhi). Indian J. Chem.; 9: No. 12, 1390-3(Dec 1971).

Triethanolamine complexes of Cd(II), Zn(II), Cu(II), Ni(II), CO(II), Mn(II), Fe(III), Cr(III), Al(III), and UO_2(II) were prepared and characterized. Thermogravimetric and differential thermal analysis studies show that several of these complexes decompose in steps, forming the metal complex containing one mole of triethanolamine as an intermediate and the metal oxide as the final product. Infrared spectra of the metal complexes were recorded. A possible structure containing a five-membered ring is suggested based on the evidences obtained in this investigation as well as those given by the earlier workers. (auth)

Isotope Effects

Refer also to abstracts 30850 and 32733.

30770 LOW FREQUENCY RAMAN SPECTRA OF $\alpha-{}^{16}O_2$, $\alpha-{}^{18}O_2$, AND $\alpha-N_2$. Mathai, P. M.; Allin, E. J. (Univ. of Toronto). Can. J. Phys.; 49: No. 15, 1973-5(1 Aug 1971).

The low-frequency Raman spectra of the ${}^{16}O_2$ and ${}^{18}O_2$ isotopes of oxygen were compared in the α phase of the solid. The frequency of the line at 27 cm^{-1} is the same in both isotopes and this confirms its interpretation as due to spin wave or magnon excitation. The libron frequencies are lower in the ${}^{18}O_2$ than in the ${}^{16}O_2$ spectrum. The integrated relative intensity of the libron lines is smaller in the ${}^{18}O_2$ spectrum. The observed $\alpha-N_2$ spectrum confirms that reported by Anderson et al. The frequencies of the lines decrease and their half-widths increase as the temperature is raised to the $\alpha-\beta$ transition. (auth)

30771 NMR STUDY OF ISOTOPE EFFECTS IN DEUTERATED LANTHANUM HYDRIDE. Zogal, O. J.; Drulis, H.; Stalinski, B. (Inst. for Low Temperature and Structure Research, Wroclaw). pp 1065-6 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

Proton NMR measurements were performed on $LaH_{1.95}D_{0.41}$ and $LaH_{0.38}D_{1.95}$ in order to test the hypothesis that the D atoms should prefer the tetrahedral sites over the octahedral sites. The experimental second moments suggest a random occupation of sites by both H isotopes, and this is confirmed by the temperature narrowing of the linewidth and the H self-diffusion, which agrees with those for $LaH_{2.36}$. It is concluded that the energy gain due to the configuration entropy is greater than that from the difference of vibration energies in the two kinds of sites. (D.L.C.)

30772 MECHANISTIC CONCLUSIONS FROM THE CURVATURE OF SOLVENT ISOTOPE EFFECTS. Albery, W. J.; Davies, M. H. (Oxford Univ). J. Chem. Soc., Faraday Trans., I; 68: No. 589, 167-81(Jan 1972).

The variation of k_x/k_0 with x the atom fraction of D in H_2O/D_2O mixtures is generally curved. Models of the transition state to fit this curve are described by fractionation factor theory. Nine general conclusions are drawn about the relationship between the model of the transition state and degree of curvature. The handling of data is much simplified by using a binomial expansion about $x = 1/2$. It is shown how the different models of the transition states which give the same curvature and overall solvent isotope effect may be represented by simple diagrams both for a single transition state and for reactions proceeding through two parallel or consecutive transition states. Some data for the solvolysis of t-butyl chloride are used to exemplify the approach. (auth)

30773 TEMPERATURE DEPENDENCE OF THE ISOTOPE EFFECT FOR THE DIFFUSION OF Na^+ IN NaCl. Rothman, S. J.; Peterson, N. L.; Laskar, A. L.; Robinson, L. C. (Argonne National Lab., Ill.). J. Phys. Chem. Solids; 33: No. 5, 1061-9(May 1972).

The isotope effect for the diffusion of Na^+ in Harshaw NaCl crystals was measured in the temperature range 589 to 796°C. The diffusion coefficients of Na^+ in NaCl are given by $D = 77 \exp [-(2.04 \pm 0.02\ eV/kT)]\ cm^2/sec$. The isotope effect, $f\Delta K$, decreases as the temperature increases, indicating a vacancy pair contribution to the self-diffusion of Na^+ in NaCl. This contribution reaches 30 to 45% near the melting point. The temperature dependence of $f\Delta K$ and D suggests $f\Delta K$ is ≤ 0.2 for Na^+ diffusion by means of vacancy pairs. This implies that, if ΔK for diffusion by vacancy pairs is greater than 0.8, f pairs is ≤ 0.25, and hence the ratio of Cl^- jumps by pairs to Na^+ jumps by pairs must be less than 0.1. Also, a large entropy for Na^+ diffusion by vacancy pairs is indicated. (auth)

30774 NITROGEN ISOTOPE EFFECTS IN COPPER TETRAMMINE/AMMONIA AND ZINC TETRAMMINE/AMMONIA SYSTEMS. Sarpal, S. K.; Gupta, A. R.; Shankar, J. (Bhabha Atomic Research Centre, Trombay, India). Indian J. Chem.; 9: No. 12, 1362-8(Dec 1971).

The nitrogen isotope effect studies in copper tetrammine–ammonia and zinc tetrammine–ammonia systems were carried out using breakthrough operation on ion exchange columns of Dowex-50 WX4, Dowex-50 WX8, and Dowex-50 WX12 resins. The behavior of these copper and zinc ammines in the various resins was first investigated. The single stage separation factors, α, were obtained from the material balance equation as well as Glueckauf's theory for breakthrough operation on ion exchange columns. The theory was used to obtain the number of theoretical plates in an ion exchange column and the breakthrough curves. There is good agreement between the α values obtained in these two ways and the experimental and computed breakthrough curves. The HETP (height equivalent to a theoretical plate) values for copper and nickel ammine–ammonia systems on Dowex-50 WX4 and Dowex-50 WX8 resin columns were computed independently also from Glueckauf's equation, using parameters like distribution coefficient, diffusion coefficient, resin particle diameter and linear flow rate of the solution. The HETP values obtained from the analysis of the column experiment data follow the expected trend and agree qualitatively with the computed values. Because of the elution of copper and zinc ammines from the various ion exchangers used, the effect of resin cross-linking on single stage separation factors is explained in terms of the isotopic equilibrium between the complex in the resin and the complex in the solution, the latter having larger number of ammonia molecules per metal ion. The difficulties in computing reliable α values for the equilibrium-$(\text{metal ammine})_{\text{aqueous}}/(\text{ammonia})_{\text{aqueous}}$ due to the additional isotopic equilibrium are discussed. (auth)

30775 INFRARED SPECTRA AND FORCE CONSTANTS OF K(SeCN) AND Ag(SeCN)-^{12}C AND -^{13}C. Buerger, H.; Schmid, W. (Technsiche Univ., Brunswick). Z. Anorg. Allg. Chem.; 388: No. 1, 67-77(Feb 1972). (In German).

The ir spectra of K(SeCN) and Ag(SeCN), natural and ^{13}C-enriched, were recorded in alkali halides and the fundamental, combination, and overtone frequencies assigned. Ag(SeCN) differs from K(SeCN); in alkali halide discs it transforms to a product that possibly has a polymeric chain structure. Anharmonicity and force constants were calculated from the observed frequencies and the isotopic splittings. f(CN/CSe) is 0.88 mdyn/Å in K(SeCN), but 0.25 mdyn/Å in Ag(SeCN); f(CN) being greater, f(CSe) smaller for Ag(SeCN) than for K(SeCN). (auth)

Isotope Exchange and Isotope Separation

Refer also to abstract 30833.

30776 . SOME PROBLEMS IN THE CALCULATION OF ISOTOPE SEPARATION FACTORS. Basov, Yu. G.; Panchenkov, G. M. (Moscow State Univ.). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 10, 1373-5(Oct 1971).

Translated from Zh. Fiz. Khim;; 45: No. 10, 2417-20(Oct 1971).

Formulas are presented for the calculation of isotope separation factors for certain processes occurring in photochemical and gas-discharge reactions. Formulas were obtained for the kinetic isotope separation factors in the recombination of atoms in two-quantum processes and in ternary collisions. A method is described for calculation of isotope separation factors in molecular excitation processes from data for the energy distribution in the radiation and also a method for the calculation of the difference between the activation energies for isotopic species. (auth)

30777 PHOTOCHEMICAL ISOTOPIC ENRICHMENT OF ^{13}C AND ^{18}O IN THE PHOTOLYSIS OF CARBON MONOXIDE. Dunn, Owen Joseph. Troy, N. Y.; Rensselaer Polytechnic Inst. (1971). 225p. University Microfilms Order No. 72-12,621.

Thesis.

The experimental conditions needed for the realization of photochemical isotopic enrichment are: (a) There must be a difference in the absorption spectrum of the isotopic species $^{12}C\ ^{16}O$, $^{13}C\ ^{16}O$, etc. (b) The excitation line must be sharp in order to cause selective excitation of one or more of the isotopic species. (c) The excited molecules must undergo a chemical reaction, the products of which will be isotopically enriched. By making use of the sharp 2062.4A line of monoisotopic atomic iodine, a selective excitation of two of the isotopic species of carbon monoxide can be accomplished through the Cameron Band System ($a^3\Pi \leftarrow X^1\Sigma^+$). The ($a^3\Pi$) CO excited molecules take part in a reaction scheme which results in CO_2 and C_3O_2 as end products. The isotopic distribution of ^{13}C and ^{18}O in these products as determined by mass spectrometric analysis shows CO_2 and C_3O_2 to be isotopically enriched and reveals a number of interesting aspects of this process. By means of absorption measurements, absorption coefficients for a number of the isotopic species of CO were determined and some of the finer details of the enrichment process uncovered. The effects of temperature and pressure change and foreign gases (He, Xe, HCN) on absorption were examined. It was learned that electronic to vibrational energy transfer followed by vibrational deactivation is an important mode of $a^3\Pi$ CO consumption in photochemical experiments with pure CO. (TSS) (Diss. Abstr. Int., B)

30778 pH-RATE PROFILES FOR THE ^{18}O EXCHANGE AND EPIMERIZATION OF A PHOSPHETANE OXIDE. RATE-LIMITING PSEUDOROTATION. Gorenstein, David G. (Univ. of Illinois, Chicago). J. Amer. Chem. Soc.; 94: No. 8, 2808-14(19 Apr 1972).

pH-rate profiles for epimerization and ^{18}O exchange of 1-phenyl-2,2,3-trimethylphosphetane 1-oxide are presented. The profiles show that the rates of epimerization and exchange are proportional to hydroxide ion concentration at pH 9 to 12 and are independent of acidity between pH 4 and 8. Epimerization is slower than exchange by factors of 5 to 140 in this pH range. In the acid region, exchange is much faster (10^4-fold at 4 M HCl) than epimerization, and only the former reaction is proportional to the hydrogen ion concentration. A rate maximum observed in dilute acid for the slower epimerization reaction is interpreted as evidence that pseudorotation of the pentacovalent intermediates is rate limiting. A rate maximum observed for exchange in strong acid is ascribed to a decrease in the activity of water. (auth)

30779 CATALYTIC STUDIES OF THE GASEOUS EXCHANGE REACTION H_2/HDO USING PLATINUM ON CHARCOAL. Hallaba, E.; Abdel-Wahab, E. M. (Atomic Energy Establishment, Cairo). Z. Anorg. Allg. Chem.; 388: No. 2, 169-76(Mar 1972).

In the gaseous exchange reaction H_2/HDO the catalyst (Pt/charcoal) of concentration 0.4 gm Pt per 100 ml catalyst proved to be highly efficient. Its preparation is simple but precaution is needed to choose, optimum conditions in activating the charcoal prior to impregnation, the right grain size to reduce channelling, the proper reduction process and an efficient purification system to remove poisons. The regeneration of the catalyst is described. The kinetics and mechanism of this reaction are discussed. (auth)

Feed Materials Processing

30780 (DOCKET-408084-3) URANIUM CONCENTRATOR. Environmental Report, Comments of Utah Department of Natural Resources. (Utah State Office of the Planning Coordinator, Salt Lake City). 12 Apr 1972. 4p. Dep. NTIS.

30781 (DOCKET-408084-4) URANIUM CONCENTRATOR. Supplemental Environmental Report, Amendment. (Rio Algom Corp., Moab, Utah). 4 Apr 1972. 6p. Dep. NTIS.

Responses to questions raised by the AEC staff in respect to mill operation and to the stabilization and long-term maintenance of the tailings area are presented. (M.C.G.)

30782 (IEA-249) COMPARATIVE STUDY OF THE YIELDS OF TWO PURIFICATION PROCESSES FOR URANIUM THROUGH ION EXCHANGE AND THROUGH SOLVENT EXTRACTION IN PULSED COLUMNS IN PREPARATION OF NUCLEAR-PURE URANIUM. Franca, J. Monteiro Jr. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Oct 1971. 31p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

The losses of nuclear grade uranium are analyzed for two different purification systems: ion exchange purification using a strong cationic resin and pulsed column solvent extraction using TBP-Varsol 35% (v/v). In the first process, all the uranium losses were computed from the beginning of the process, step by step, until the final point, from which a value of 11.7% was obtained. In the second process, a yield analysis was done in the extraction step and continued at the scrub step, where the highest loss percentage is encountered. About 16.7% was estimated as the total loss for the solvent extraction process. (auth)

30783 URANIUM RECOVERY FROM DILUTE SULFATE SOLUTION BY USING A CONTINUOUS ION-EXCHANGE TECHNIQUE. Javed, N. A. (Imperial Coll. of Science and Tech., London). J. Metals; 23: No. 8, 33-7(Aug 1971).

The method developed by Cloete and Streat (Nature, Vol. 200, 1963, pp 1199-1200) for continuous solid-fluid contact was adopted for recovery of uranium from dilute sulfate solutions. The flow cycle consists of 3 separate parts. A periodically modulated flow rate of fluid to a cascade of contacting stages is used. The solid is transferred in a direction countercurrent to the net flow of fluid. Uranyl sulfate solution was pumped from one end of the unit and the wet resin was pumped from the opposite end. The overall recovery was 81% and the stage efficiency was about 60.3%. (M.C.G.)

Radiation Chemistry

Refer also to abstracts 30722, 30745, 30849, 30854, 31059, 31216, 31428, 32612, 32614, and 32618.

30784 (CONF-701148-(Vol.2)) PROCEEDINGS OF THE CHEMISTRY SYMPOSIUM, IIT, MADRAS, NOVEMBER 25-28, 1970. VOLUME II. RADIATION TECHNOLOGY AND APPLIED NUCLEAR CHEMISTRY. (Department of Atomic Energy, Bombay (India). Chemistry and Metallurgy Committee). 425p.

Fifty-two papers and abstracts of two additional papers are included. Separate abstracts were prepared for 47 papers. One paper was previously abstracted for NSA. For the abstract of this paper see CONF-701148 in the Report Number Index. (M.C.G.)

For abstracts of individual papers see: 30644-30648, 30693-30703, 30741-30744, 30760, 30813-30815, 30849-30851, 30870-30872, 30900-30902, 30911, 30929, 30930, 30960, 31002, 31072, 31113, 31133, 31216, 31217, 31388, 31414, 32410, and 32923.

30785 (COO-2086-30) RADIOLYSIS STUDIES ON REACTIVE INTERMEDIATES. Technical Progress Report, April 30, 1971-April 1, 1972. Kevan, Larry (Wayne State Univ., Detroit, Mich. Dept. of Chemistry). 30 Apr 1972. Contract AT(11-1)-2086. 17p. Dep. NTIS.

Research progress is reported on: paramagnetic relaxation studies of the spatial distribution of trapped species, mechanisms of electron trapping in glassy matrices, application of the semicontinuum model to trapped electrons, discovery of two photon transitions associated with trapped electrons in organic glasses, and Hall mobility measurement of photoexcited electrons in glassy and crystalline matrices. (M.C.G.)

30786 (NP-19267) REACTIONS IN IRRADIATED GASEOUS TRIFLUOROMETHYL IODIDE. Roy, Colin Robert (Melbourne Univ., Parkville (Australia). Dept. of Physical Chemistry). Jul 1970. 222p. Dep. NTIS (U. S. Sales Only).
Thesis.

Rapid iodine production was observed when gaseous CF_3I, C_2D_5I, CH_3I, and C_2H_5I were irradiated using a 2-MeV electron source. Kinetics of I_2 formation were attributed to the abstraction reaction $I(^2P_{1/2}) + RI \rightarrow I_2 + R$. The emission accompanying the transition of the excited atomic iodine $[I(^2P_{1/2})]$ to the ground state $[I(^2P_{1/2})]$ was monitored and the efficiency of deactivation by argon, alkyl iodide, and iodine was compared. The radiolysis of fluorocarbons and of methyl and trifluoromethyl iodide is reviewed and on the basis of fluorocarbon and iodine products analysis in the presence of free radicals scavengers it is proposed that at least 2 different processes are involved in the production of CF_4. (Australia)

30787 (RRL-3238-391) QUARTERLY REPORT, JANUARY 1, 1972-MARCH 31, 1972. (Mellon Inst. of Science, Pittsburgh, Pa. Radiation Research Labs.). 12 Apr 1972. Contract AT(11-1)-3238. 25p. Dep. NTIS.

Research progress is reported on the radiolysis of various organic compounds, aqueous solutions, dielectric solutions, and fluorocarbon gases. ESR spectral studies on free radicals produced in these radiolyses are reported. (M.C.G.)

30788 COMPARISON BETWEEN THE RADICALS FORMED BY RADIATION IN BARBITURIC ACID AND ITS 2-THIO DERIVATIVE. Meloe, T. B.; Colombetti, G.; Henriksen, T. (Univ. of Oslo). Mol. Phys.; 22: No. 6, 1055-67(1971).

The radicals formed by MeV electron irradiation in 2-thiobarbituric acid single crystals were studied by ESR spectroscopy. The main radical is formed by abstraction of one of the protons bonded to C_5. The electronic structure of this radical was compared to that of the related radical formed in ordinary barbituric acid. Both the experimental data as well as the molecular orbital calculations show that when oxygen is substituted by sulphur the isotropic proton splitting is reduced and the g-value anisotropy increased. This is explained by a transfer of unpaired spin density from C_5 to the sulphur atom. (auth)

30789 UV TRANSMISSION CURVES OF γ RAY-IRRADIATED HIGH MOLECULAR FILMS. Matsui, Etsuzo; Shimizu, Yoshihiro (Toyo Junion Coll. of Food Tech., Kawanishi, Japan). Toyo Shokuhin Kogyo Tanki Daigaku, Toyo Shokuhin Kenkyusho Kenkyu Hokokusho; No. 9, 94-9(Mar 1970). (In Japanese).

The uv-transmission curves of high-molecular-weight films are affected by γ-irradiation. At doses of 1×10^6 r, no significant effects on films were observed. At doses of 7×10^6 r, the uv transmission curves of pure cellophane, poly(vinyl alcohol), polyethylene, polypropylene, poly(vinyl chloride), and polycarbonate change their shapes and patterns, whereas those of polystyrene and polyester remain unchanged. Some of the films brown on irradiation; the tints of color gradually change with the lapse of time. The uv transmission curves of poly(vinylidene chloride) and poly(vinyl chloride), irradiated at doses of 4.5×10^6 r, are shifted slowly downwards, indicating further decomposition. On the contrary, the uv curve of irradiated polycarbonate is shifted downwards for a time, and then upwards, indicating restoration of chemical status of the films. At doses of 1×10^7 r, the progressive changes in the uv curves of poly(vinylidene chloride) and polycarbonate are more remarkable. The uv curves of irradiated and discolored glass plate, probably containing free radicals, also are shifted upwards during storage. (auth) (Japan)

30790 REACTION KINETICS OF PHOTOCHEMICAL REDUCTION OF URANYL-ION BY ALCOHOLS. Kireeva, G. N.; Savel'eva, V. I.; Efimova, V. S. Tr. Mosk. Khim.-Tekhnol. Inst.; No. 67, 59-61(1970). (In Russian).

The photochemical reduction of the uranyl ion by alcohols conforms to a first-order equation relative to uranyl ion and alcohol. The apparent activation energies of the reactions and the values of the preexponential factors were calculated. (tr-auth)

30791 INTERPRETATION OF THE EFFECTS OF IONIC SCAVENGERS AT HIGH L.E.T. IN IRRADIATED CYCLOHEXANE, BASED ON AMBIPOLAR DIFFUSION. Burns, W. G.; Reed, C. R. V. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc., Faraday Trans., I; 68: No. 589, 67-72(Jan 1972).

Some results on the effects of ionic scavengers in cyclohexane irradiated at high L.E.T. are reinterpreted on the basis of ambipolar diffusion. It is shown that at high L.E.T., 200 keV μm^{-1}, the density of ions is great enough for ion atmospheres to be set up, so that the diffusion of oppositely charged ions is mutually influenced (the Debye length is much smaller than the track radius), throughout the significant lifetime of the track. Expressions are derived for the relevant ambipolar diffusion constants with scavenging occurring, which change as scavenging and neutralization of ions take place. These, applied to a diffusion model of the track, yield curves of G(scavenged ions) against scavenger concentration which agree well with experiment. These concepts should be helpful in interpreting the scavenging of ions produced by the high L.E.T. component of γ and fast electron irradiation. (auth)

30792 UNSTABLE INTERMEDIATES. PART 107. RADIATION DAMAGE PRODUCTS IN CHOLINE CHLORIDE. Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem Soc., Faraday Trans., I; 68: No. 591, 216-20(Feb 1972).

At 77 K the major radicals detected by ESR in γ-irradiated cholinechloride$[Me_3N^+CH_2CH_2OHCl^-]$ were $\dot{C}H_2CH_2OH$, as previously suggested, and a species containing one hydrogen and one chlorine atom, closely resembling $ClOH^-$. The latter was lost on annealing. Irradiation at room temperature gave only the radical Me_3N^+, which was rotating at this temperature, but stationary at 77 K. A mechanism is outlined which could account for these radicals and for the chain mechanism of the decomposition. (auth)

30793 DISSOCIATION EQUILIBRIUM OF NITROFORM IN POLAR SOLVENTS STUDIED BY PULSE RADIOLYSIS. Chaudhri, Shamim A.; Asmus, K.-D. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). J. Chem. Soc., Faraday Trans., I; 68: No. 3, 385-92(1972).

The dissociation equilibrium $C(NO_2)_3H \rightleftharpoons C(NO_2)_3^- + H^+_{sol}$ and the related kinetics were studied for various solvents (alcohols, acetone, and water) by means of pulse radiolysis. Nitroform anions were produced by radiation chemical reduction of tetranitromethane dissolved in these liquids. The dissociation constant K of nitroform decreased with decreasing dielectric constant; its value ranged from 6.3×10^{-1} M for water to 2.5×10^{-7} for t-butanol. K essentially controlled by the rate constant k_n for the neutralization of $C(NO_2)_3^-$ by solvated protons (3.4×10^4 M^{-1} s^{-1} in water and 5.0×10^9 M^{-1} s^{-1} in t-butanol), while the rate of dissociation of $C(NO_2)_3H$ depended relatively little on the nature of the solvent. A linear relationship was found between log k_n and log K. Nitroform anions were also neutralized by proton transfer from solvent molecules. The rate constant for this process did not vary much with the properties of the solvent. Equivalent conductivities for $C(NO_2)_3^- + H^+_{sol}$ ion pairs were also determined. (auth)

30794 RADIATION CHEMISTRY OF AQUEOUS SOLUTIONS. Scholes, G. (Univ. of Newcastle-upon-Tyne, Eng.). Annu. Rep. Progr. Chem., Sect. A; 67: 169-90(1970).

A review of recent work is presented under the following headings: introduction; mechanism of water decomposition; the hydrated electron (physical properties, structure); aqueous inorganic systems (small radicals and molecules, cations and anions); aqueous organic systems (aliphatic compounds, aromatic compounds, heterocyclic compounds). (155 references) (UK)

30795 ACTIVATION OF TITANIUM CHLORIDES FOR ETHYLENE POLYMERIZATION BY γ-IRRADIATION. Bukatov, G. D.; Zakharov, V. A.; Ermakov, Yu. I.; Shirikov, N. G. (Inst. of Catalysis, Novosibirsk, USSR). Kinet. Katal.; 13: No. 5, 1357-8 (Sep-Oct 1971). (In Russian).

$\alpha-TiCl_3$ upon irradiation with ^{60}Co γ rays manifests catalytic activity in ethylene polymerization, whereas the non-irradiated material is inactive. Unground $TiCl_3$ possesses some catalytic activity, but this is enhanced by γ radiation. These catalytic effects are compared to the addition of the compound $AlEt_2Cl$ which raises the catalytic activity of $TiCl_3$ considerably. (K.S.W.)

30796 RADIATION-INDUCED DECOMPOSITION OF LIQUID n-HEPTANE. I. EFFECT OF DOSE ON LIQUID n-ALKANE PRODUCTS. Montiel C., R.; Reyes L., J. (Comision Nacional de Energia Nuclear, Mexico City). Rev. Mex. Fis., Supl. Fis. Apl.; 20: 37-53(1971).

The radiolytic yields and G-values of liquid n-alkane products were determined as a function of dose for the radiolysis of liquid n-heptane with 1.0-MeV electrons. A mechanism for the radioinduced reactions is proposed in order to explain the experimental data. (auth)

30797 RADIATION TREATMENT OF PETROLEUM AND PETROLEUM PRODUCTS. I. EFFECT OF DOSE AND DOSE RATE ON CRUDE FROM POZA RICA/ORDONEZ, PEMEX. Reyes Lujan, Javier (Univ. Nacional Autonoma de Mexico, Mexico City). Rev. Mex. Fis., Supl. Fis. Apl.; 20: 1-7(1971).

The effects of dose in the radiolytic treatment of crude oil is to increase the content of heavy products, due to the reactions between the radioinduced radicals to form hydrocarbons with molecular weights higher than the originals. The yield of light products increases with dose rate, due to the reactions between the radicals and the atomic hydrogen. (auth)

30798 UNSTABLE INTERMEDIATES. PART 109. ELECTRON SPIN RESONANCE DATA FOR BORON-CARBON AND NITROGEN-CARBON π-RADICALS: A COMPARISON BETWEEN π^1- AND π^3-RADICALS. Lyons, A. R.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., Faraday Trans., II; 68: No. 3, 502-8(1972).

The radicals H_2C-BMe_2 and H_2C-BMe_2 (NH_3) in γ-irradiated trimethyl boron and its ammonia adduct, were identified by their ESR spectra. Various R_2CNR_2 radicals were also prepared by γ-irradiation of amines at 77°K followed by annealing to ca. 130°K. The former have a π^1 structure and the latter a π^3 structure. The results suggest that the former are strictly planar and that the latter are locally planar at carbon but slightly pyramidal at nitrogen. It is postulated that the α-proton hyperfine coupling in the amine radicals is a function of the degree of twist about the $C-N$ bond. (auth)

30799 RADIATION-INDUCED OXIDATION OF POLY-ε-CAPROAMIDE IN THE PRESENCE OF SECONDARY AROMATIC AMINES. Furman, E. G.; Fomenko, A. S.; Abramova, T. M. (Inst. of Physical Chemistry, Moscow). Vysokomol. Soedin., Ser. A; 13: No. 10, 2236-43(Oct 1971). (In Russian).

The influence of some secondary aromatic amines on the radiolysis and radiation-induced oxidation of polycaproamide was investigated. Introduction of these compounds into polycaproamide does not affect significantly the accumulation of primary radicals and the hydrogen evolution. During the radiation-induced oxidation of polycaproamide secondary aromatic amines do not influence the peroxide yield at -78°C. Temperature increase up to 30 and 95°C gives higher radiation yields of peroxides in polycaproamide containing no additions. The secondary aromatic amines whose half-wave potential of polarographic oxidation is below 0,70 v (vs. SCE) reduce the peroxide yield in polycaproamide down to the value characteristic of a non-chain reaction. The antioxidant 2,2′-bis-(p-phenylaminophenoxy)diethyl ether does not affect the yield of carbonyl compounds at -78 and 30°C. The radiation-induced oxidation of polycaproamide containing secondary aromatic amines leads to formation of nitrogen oxide radicals with the EPR spectra characteristic of these radicals in a solid matrix. (auth)

30800 RADIATION-INDUCED TRANSFORMATIONS IN EPOXY OLIGOMERS BASED ON EPICHLOROHYDRIN AND p,p′-DIHYDROXYDIPHENYLPROPANE. Sidyakin, P. V.; Karpov, V. L.; Egorov, B. N.; Egorova, Z. S. Vysokomol. Soedin., Ser. A; 13: No. 10, 2195-2206(Oct 1971). (In Russian).

The radiation-induced transformations in solid epoxy resin based on epichlorohydrin and p,p′-dihydroxydiphenylpropane were studied by ir-spectroscopy, x-ray analysis, ESR and chemical analysis. The main products of resin radiolysis were identified. On the basis of the results obtained, the mechanisms of radiation-induced cross-linking, degradation and gas formation in diphenylolpropane-based epoxy resins are suggested. Some general features of radiolysis and radiation stability of such epoxy resins are formulated. (auth)

30801 ENERGY PARTITION IN THE γ-RADIOLYSIS OF GASEOUS $H_2S + N_2O$ MIXTURES. Huyton, D. W.; Woodward, T. W. (Univ. of Salford, Eng.). J. Chem. Soc., Faraday Trans., II; 68: No. 590, 144-52(Jan 1972).

Measurement of ion yields $G_m(=100/W_m)$, where W_m is the average energy required to produce an ion pair in the mixture in gaseous H_2S-N_2O mixtures indicates that the energy partition parameter "a" = 0.53 holds for mixtures of stopping power fraction $Z = P_1[P_1 + (S_2/S_1)P_2]$ from $0.15 \rightarrow 1.0$, and perhaps over the whole range of Z. P_1 and P_2 are the partial pressures and S_1 and S_2 are the stopping powers relative to air of H_2S and N_2O respectively. The radiation yields of H_2 and N_2 in the mixtures $G(H_2)_m$ and $G(N_2)_m$ yield this value of "a" = 0.53 probably restricted to the range $Z = 0.45 \rightarrow 1.0$. A scheme of energy transfer from an excited state of N_2O to H_2S is suggested for the deviation below $Z = 0.45$. For $Z > 0.45$ an excited state of N_2O is postulated that does not transfer energy to H_2S. A mechanism of ionization energy transfer plus reactions of O and NO_2 with H_2S is suggested as an explanation of the high sulphur yields at low Z. (auth)

30802 YIELD OF TRIPLET STATE BENZENE IN THE PULSE RADIOLYSIS OF SOLUTIONS OF SOME AROMATICS. Baxendale, J. H.; Fiti, Maria (Univ. of Manchester, Eng.). J. Chem. Soc., Faraday Trans., II; 68: No. 592, 218-22(Feb 1972).

The yields of triplet states of naphthalene, biphenyl, and anthracene formed in the pulse radiolysis of 0.1 mM-50 mM benzene solutions determined. When allowance is made for the amount of triplet arising from the singlet states, the remaining triplet yields can be accounted for quantitatively over the whole concentration range by Stern-Volmer kinetics of transfer from the triplet state of benzene. The yields give $G(B^T)_0 = 4.2$ for the primary yield of triplet benzene, which agrees with the values obtained using the cis-trans isomerization technique. The half-life of the benzene triplet in liquid benzene at 20°C is estimated to be 2.3 ns. (auth)

30803 IRRADIATION OF STARCH. STUDY OF THE LOW MOLECULAR DEGRADATION PRODUCTS. Scherz, H. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Staerke; 23: No. 8, 259-67(1971). (In German).

Potato starch was irradiated with 10-MeV electrons (dose: 5 Mrad). After extraction and separation by two-dimensional thin-layer chromatography 15 substances were obtained. By color reaction they could be classified into monosaccharides, desoxy compounds, sugar anhydrides, furan and probably also pyrone compounds. The gas chromatographic separation of the trimethylsilyl ethers of the substances obtained after reduction of the extract with potassium borohydride gave approximately 25 compounds; mass spectra were taken of the main peaks. The position of the carbonyl groups in the individual compound was obtained by reducing the extract with sodium borodeuteride and by observation of the mass-shift of the single fragmentations in the mass spectra. Their evaluation revealed the presence of aldoses, deoxy sugars, deoxycarbonyl sugars, and cyclic compounds, probably dihydropyrones and dihydrofurans. (INIS)

30804 CHEMICAL EFFECTS DUE TO LOW-ENERGY ELECTRON IMPACT ON THIN FILMS OF CYCLOHEXANE AND n-HEXANE AT 77°K. **Matsushige, Toshiaki; Hamill, William H. (Univ. of Notre Dame, Ind.). J. Phys. Chem.; 76: No. 9, 1255-9(27 Apr 1972). (COO-38-813).**

Films (570 to 840 Å) of cyclohexane and n-hexane at 77°K were subjected to low-energy electron impact and the products were analyzed. The yield of bicyclohexyl onsets at ~8.5 eV, maximizes at ~13 eV, and minimizes at ~30 eV. Of the C_{12} products from n-hexane only n-dodecane was resolved in the gas chromatogram. The onset is well below the threshold of optical absorption. Only the n-hexane fragment hydrocarbon products ethane, propane, n-butane, n-pentane, and their congruent olefins (in the order of decreasing yields) were measured in detail. Their yield vs energy profiles were similar with onsets at ~3.5 eV, maxima at ~6.5 eV, and minima at ~7.0 eV. The results for n-hexane at low energy are attributed to decompositions from vibrationally excited, low-lying triplet states by direct excitation with spin exchange. (auth)

30805 ROLE OF ADDED OLEFINS AND OXYGEN IN THE GAS-PHASE RADIOLYSIS OF n-BUTANE. **Fujisaki, Noboru; Fujimoto, Ikuo; Hatano, Yoshihiko (Tokyo Inst. of Tech.). J. Phys. Chem.; 76: No. 9, 1260-4(27 Apr 1972).**

The addition of ethylene, propylene, and cyclopropane to n-butane caused a definite increase in the yields of ethane, propane, and respectively, in the gas-phase radiolysis of n-butane containing 5 mol % oxygen. An attempt was made to determine the extent to which these additives undergo H- and H_2-transfer reactions. Assuming the relative rates for H and H_2 transfer, $k(H)/k(H_2)$, to the propylene molecule from the n-butane parent ion to be 0.1, the relative rates $k(H)/k(H_2)$ for the n-butane parent ion–ethylene and n-butane parent ion–cyclopropane reaction pairs are determined, respectively, to be 0.9 and 1.8. The influence of the occurrence of H- and H_2-transfer reactions between the n-butane parent ion and the added ethylene or propylene on the mechanism of the hydrogen formation is also discussed. The fact that the G value of nitrogen from n-butane–1.1 mol % nitrous oxide mixtures decreased from 12 to 0 upon the addition of 2.6 mol % oxygen suggests that oxygen scavenges an electron or its equivalent as well as a thermal free radical in the gas phase. (auth)

30806 ELEMENTARY PROCESSES IN THE RADIOLYSIS OF AQUEOUS SULFURIC ACID SOLUTIONS. DETERMINATIONS OF BOTH G_{OH} AND $G_{SO_4^-}$. Matthews, R. W.; Mahlman, H. A.; Sworski, T. J. (Oak Ridge National Lab., Tenn.). J. Phys. Chem.; 76: No. 9, 1265-72(27 Apr 1972).

Kinetic evidence is presented for concurrent production of two oxidizing radicals in the radiolysis of aqueous sulfuric acid solutions: OH and SO_4^- radicals that are presumed to result from direct action of ionizing radiation on water and sulfuric acid anions, respectively. The evidence was obtained from the dependence of $G(Ce^{III})$ on cerium(III) and either formic acid or 2-propanol concentrations in the radiolysis of cerium(IV)–cerium(III)–formic acid mixtures and cerium(IV)–cerium(III)–2-propanol mixtures. Determinations of G_{OH} and $G_{SO_4^-}$ required the use of a computer for least-squares fit of experimental data to complex kinetic equations containing up to 22 dependent variables. Applicability of the kinetic equations is indicated by the excellent agreement for two determinations in 4.0 M sulfuric acid: $G_{OH} = 1.76 \pm 0.19$ and $G_{SO_4^-} = 0.95 \pm 0.18$ with 2-propanol solutions; $G_{OH} = 1.78 \pm 0.03$ and $G_{SO_4^-} = 0.94 \pm 0.03$ with formic acid solutions. A small but significant yield of SO_4^- was determined in 0.4 M sulfuric acid: $G_{OH} = 2.60 \pm 0.04$ and $G_{SO_4^-} = 0.20 \pm 0.04$. No evidence was obtained for oxidation of sulfuric acid anions by precursors of OH radical such as H_2O^+, since G_{OH} was found to be proportional to electron fraction water. (auth)

30807 EFFECT OF TEMPERATURE ON THE γ RADIOLYSIS OF AQUEOUS SOLUTIONS. Balakrishnan, I.; Reddy, M. P. (National Chemical Lab., Poona, India). J. Phys. Chem.; 76: No. 9, 1273-9(27 Apr 1972).

$G(-Ce^{4+})$ in the aqueous ceric sulfate system is constant in the region 0 to 30° and thereafter drops steadily, whereas $G(Fe^{3+})$ in the deaerated ferrous sulfate system remains strictly constant at 8.1 ± 0.05 from 0 to 120°. From this it follows rigorously that G(OH) is constant at least from 0 to 30°. This fact makes it possible to identify the formation, in addition to phenol, of two aldehydes in the γ radiolysis of the aerated neutral aqueous benzene system and to characterize them as the α and β isomers of hydroxymucondialdehyde (HMD). The sum of the yields of the three products is equal to G(OH). From 40° upward G(phenol) rises sharply and reaches a value of ~5 at 220°. At 60° and above the HMD appears to be replaced by ketonic products from fragmentation of the benzene ring. An analysis of the temperature coefficient of $G(Fe^{3+})$ of the aerated Fricke system suggests that it is in the main due to a competition between two reactions, $H + O_2 \rightarrow HO_2$ and $H_2^+ + Fe^{2+} \rightarrow H_2 + Fe^{3+}$. The anomaly noticed at the higher temperatures in the ceric and aqueous benzene systems is interpreted as evidence of onset of oxidizing action of HO_2. Adverse consequences of this study for the diffusion theory of radiolysis are discussed. (auth)

30808 PULSE RADIOLYSIS OF DIOXANE AND DIOXANE + WATER MIXTURES. THE YIELD OF FREE SOLVATED ELECTRONS AND KINETICS OF THE RADICAL REACTIONS. **Chaudhri, Shamim A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). J. Phys. Chem.; 76: No. 9, 1279-83(27 Apr 1972).**

The yield of the solvated electrons in pure dioxane which escape geminate recombination with the positive ions was determined to be 0.19. The dioxane radical reduces tetranitromethane to nitroform anion, $C(NO_2)_3^-$, through an electron transfer process. The kinetic data support a reaction mechanism involving an "intermediate complex" in equilibrium with the reactants. Both the equilibrium constant K and first-order rate constant k of decomposition of the complex were calculated. K and k were found to decrease with decreasing water contents of dioxane–water mixtures. The equivalent conductivity of the ion pair, $C(NO_2)_3^- + H_{solv}^+$ over a whole range of dioxane–water compositions was measured. From extrapolations a value of 5 $ohm^{-1}\ cm^2\ equiv^{-1}$ for $\Lambda_{(C(NO_2)_3^- + H_{solv}^+)}$ in pure dioxane was obtained. (auth)

30809 AVERAGE VALUE OF THE CROSS SECTION FOR $H + HBr \rightarrow H_2 + Br$ OVER THE 0.35- TO 1.7-eV COLLISION ENERGY RANGE. Gann, R. G.; Dubrin, J. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-905. J. Phys. Chem.; 76: No. 9, 1321-3(27 Apr 1972).

An average cross section for the title reaction was computed from certain previously reported hot atom (photochemical-recoil) data. The cross section is equal to 1.6 ± 0.3 $Å^2$, and it is defined as $S_R(E)_{HBr} = \int_{0.35}^{1.7} h'(E)S_R(E)dE$, where $S_R(E)$ is the corresponding microscopic quantity and $h'(E)$ is a known normalized distribution function of energies. (auth)

30810 RADICAL CONCENTRATION GROWTH IN IRRADIATED SOLID SYSTEMS. A SIMPLE MODEL INVOLVING COMPETITIVE RADICAL PRODUCTION, THERMAL DECAY, AND RADIATION-INDUCED DECAY. **Ogren, Paul J. (Maryville Coll., Tenn.). J. Phys. Chem.; 76: No. 9, 1324-6(27 Apr 1972).**

A model for the growth of radical concentrations in solids undergoing irradiation is developed assuming three processes known to be important in several systems: (1) a constant radical production rate, (2) nonexponential first-order thermal decay of radicals formed at a particular time, and (3) radiation-induced decay proportional both to the dose rate and the number of radicals present at a particular time. The model is then applied with satisfactory results to the growth of ethyl radicals in γ- or β-irradiated ethyl iodide glass at 77°K. (auth)

30811 RADIOLYTIC TREATMENT OF ORGANIC INDUSTRIAL WASTES IN A PRESSURIZED OXYGEN ATMOSPHERE. Case, Forrest N.; Smiley, David E. (to United States Atomic Energy Commission). U. S. Patent 3,650,926. 21 Mar 1972. Filed 7 Oct 1969.

A method is proposed for increasing the light transparency and reducing the biological oxygen demand of organic-containing waste solutions by exposing such solutions to penetrating (γ) radiation under pressure of an oxygen-containing atmosphere of at least 1000 psi until the desired degree of optical and ultraviolet transmittancy as well as biological oxygen demand have been reached. (auth)

30812 TRAPPING AND EMISSION CENTERS IN THERMOLUMINESCENT BARIUM SULPHATE. **Luthra, J. M.; Gupta, N. M. (Bhabha Atomic Research Centre, Trombay, India). pp 135-49 of Proceedings of the Chemistry Symposium, 1970. Vol. I. Bombay; Dept. of Atomic Energy (1970).**

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.1).

Emission and trapping centers responsible for thermoluminescence emission in γ-irradiated barium sulfate doped with different impurities were investigated by studying thermoluminescence emission and ESR spectra. Transitions between different energy levels of the impurity ions present are responsible for the emission. The room temperature ESR studies of irradiated samples show the evidence of SO_4^- radical. These radicals and the defect traps introduced by the dopants act as trapping centers. (auth)

30813 RADIATION INDUCED SULFOCHLORINATION. Rao, K. N.; Moorthy, P. N. (Bhabha Atomic Research Centre, Trombay, India). pp 23-9 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.2).

The use of γ radiation to catalyze the direct sulfochlorination of hydrocarbons with a mixture of sulfur dioxide and chlorine is discussed. Because the radioinduced reactions are chain reactions and therefore have high G-values, the use of radiation becomes more economical. An experimental study is described. (M.C.G.)

30814 RADIATION PROCESSING OF WPC AND DRIERITE PLASTIC COMBINATIONS. Adur, A. M.; Majali, A. B.; Thacker, R. C. (Bhabha Atomic Research Centre, Bombay). pp 31-41 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.2).

The radiation processing of a few inexpensive indigenous timbers as well as technical grade drierite (mainly anhydrous $CaSO_4$)–plastic combinations is described. The wood species were impregnated with styrene–polyester mixtures using emulsion techniques. Tiles were prepared from the drierite using a mixture of styrene and polyester. The addition of cement to drierite was found necessary for structural considerations. The resultant plastic combinations were evaluated for their physical and mechanical properties. The tiles were also tested for their chemical resistance. (auth)

30815 (n,γ) RADIOLYSIS OF CRYSTALLINE INORGANIC HALATES. PART IV. SODIUM IODATE. Arnikar, H. J.; Dedgaonkar, V. G.; Shrestha, Kamal K. (Univ. of Poona, India). pp 87-91 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.2).

Data are presented for retention in (n,γ)-irradiated sodium iodate and the effects of thermal and radiation annealing thereon. Thermal treatment prior to (n,γ) reactions in sodium iodate has no effect on the retention while subsequent thermal annealing leads to the normal pattern of increased retention, increasing with time and temperature of annealing. Results show the T_{min} of annealing is −11.2 and −2.7°C for irradiation at 0 and 30°C, respectively. Efforts at annealing by γ doses administered (i) prior to and (ii) subsequent to (n,γ) reactions show only $\mp$3% change of R value. Irradiation of aqueous solutions of sodium iodate showed an increase in retention from 28 to 32% as the concentration is varied from 9×10^{-3} M to saturation. (auth)

30816 CHEMICAL SHIFT IN THE GAMMA-IRRADIATED C_2H_5OH–C_2H_5OK–$H_2O(D_2O)$ SYSTEM. Koch, F.; Znamirovschi, V. (Univ. of Cluj). pp 339-40 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

Proton magnetic resonance measurements were carried out on liquid $C_2H_5OH - C_2H_5OK$ at 60 Mc after irradiation with 4.6×10^6 rad of ^{60}Co γ rays. As the potassium concentration increased in the irradiated solutions, the OH signal shifted towards higher fields; this may be explained by the dissociating action of the radiation on the bound C_2H_5OH. Solutions containing different deuterium concentrations were also studied. In nonirradiated solutions, there was no change in the chemical shift, but after irradiation, a shift to lower fields is seen. This may be explained by the preferential dissociating action of the radiation on the heavy water molecules. (D.L.C.)

30817 ENDOR ON RADICALS OF GLYCINE II AND III IN IRRADIATED TGS. Welter, M.; Windsch, W. (Karl Marx-Univ., Leipzig). pp 435-7 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

ENDOR measurements were carried out at 77 and 300°K after irradiation of triglycine sulfate by a 20-kV x-ray source. The ENDOR spectrum shows two sets of lines, each of which arises from four inequivalent protons. The spectra could be assigned to radicals of the glycine molecules G II and G III which differ in the ferroelectric phase. The hfs coupling is analyzed. The splitting disappears at the Curie point, showing two equivalent radicals in the paraelectric phase. (D.L.C.)

30818 MOLECULAR STRUCTURE OF N-SUBSTITUTED AMINO ACID RADICALS BY AN ESR STUDY OF X-IRRADIATED SINGLE CRYSTALS. Lassmann, G.; Damerau, W. (Institut fuer Biophysik, Berlin). pp 563-6 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

Single crystals of N-benzoylalanine and sarcosine were x-irradiated and the resulting free radicals studied by ESR. Analysis of the spectra yielded the g- and hyperfine tensors which are tabulated. Spin densities and proton couplings are discussed. (D.L.C.)

30819 CRYSTAL STRUCTURE EFFECT IN THE GAMMA IRRADIATION OF PARA-DICHLOROBENZENE BY NQR SPECTROSCOPY. Hadjoudis, E. K.; Milia, F. K.; Papanicolaou, B. (Democritus Nuclear Research Center, Athens). pp 1048-53 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

The effects of polymorphic crystal structure (α-, β-, and γ-forms) on the gamma radiosensitivity of p-dichlorobenzene were studied using nuclear quadrupole resonance (NQR) of ^{35}Cl. The height of the NQR line decreased upon γ irradiation with a dose of 1.1×10^8 R, by an amount of 21% for the α-form, 10% for the β-form, and 5% for the γ-form. Thus, the β-form is more stable than the α-form. The temperature dependence of the NQR frequency at low temperatures was studied, and the $\alpha \rightleftharpoons \gamma$ transformation was followed with a polarizing microscope. (D.L.C.)

30820 SHORT-LIVED FREE RADICALS IN AQUEOUS SOLUTIONS OF PURINES. Nicolau, Cl. (Inst. of Virology, Bucharest). pp 1144-51 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

Results of previous research already reported are summarized: The radicals OH· and NH_2· were produced by reaction of Ti^{3+} with H_2O_2 or NH_2OH, and reacted with pyrimidine bases, nucleosides, and purines. The resulting paramagnetic species were identified using EPR. The OH· radicals and alcohols were also flowed together in three-flow experiments to produce abstraction alcohol radicals, which were then reacted with caffeine, and the EPR spectra of the resulting adduct radicals measured. The three-way flow system was again used in simulating the radioprotective mechanism of organic sulfydryls and disulfides; cysteine and cystine solutions were added after reaction of HO· or NH_2· with the organic target molecules. This results in the disappearance of the uracil spectrum, followed in cysteine by a triplet signal from a radical $-CH_2-S\cdot$. (16 references) (D.L.C.)

30821 RADIATION CHEMISTRY OF DNA MODEL COMPOUNDS. PART II. ALKYL PHOSPHATE CLEAVAGE OF ALIPHATIC PHOSPHATES INDUCED BY HYDRATED ELECTRONS AND BY OH RADICALS. von Sonntag, C.; Ansorge, G.; Sugimori, A.; (and others) (Max-Planck-Institut fuer Kohlenforschung, Muelheim an der Ruhr, Ger.). Z. Naturforsch.; 27b: No. 4, 471-2(Apr 1972).

Studies on the radiation chemistry of aqueous solutions of aliphatic phosphates revealed details that might shed some light on the chemical mechanisms of radioinduced strand breaks in DNA and related compounds. Pulsed radiolysis techniques were used in measurements of the rate constant of OH attack on trimethyl phosphate and on sodium dimethyl phosphate in N_2O-saturated solutions; $k = 8 \times 10^7$ mole^{-1} sec^{-1} for both phosphates. Initial G values of acid formation in the γ radiolysis of aqueous N_2O-saturated solutions of trimethyl phosphate, sodium dimethyl phosphate, and disodium methyl phosphate at room temperature are tabulated. G values were found to increase with an increase in dose and pH. Results indicate that in radioinduced strand breaks of DNA, a preferred radical attack at carbon 3 followed by a hydrolytic bond cleavage is likely. (J.G.B.)

30822 ESR SPECTRA OF VINYL RADICALS STABILIZED ON SILICA GEL SURFACES. Nagai, S.; Ohnishi, S.; Nitta, I. (Japan Atomic Energy Research Inst., Neyagawa City, Japan). Chem. Phys. Lett.; 13: No. 4, 379-81(15 Mar 1972).

The ESR spectra of the vinyl and 1-methylvinyl radicals adsorbed on silica gel were studied in a wide temperature range from −196 to +25°C. The observed spectra changed with temperature reversibly and showed unusual variations in the widths of the hf lines. (auth)

30823 TITANIUM(III) SULFATE DOSIMETER USING AMPEROMETRY. Goto, Masashi; Idota, Yoshio; Ishii, Daido (Nagoya Univ., Japan). Nippon Kagaku Kaishi; No. 1, 66-71 (Jan 1972). (In Japanese).

When a sulfuric acid aqueous solution of titanium(III) sulfate is irradiated by ^{60}Co γ rays, titanium(III) is oxidized to titanium(IV) through the radiolysis products of water. The chemical dosimeter based on the decrease of titanous ion was investigated to measure continually and automatically a relatively large dose. The oxidized amounts of titanium(III) were determined amperometrically. The dropping mercury electrode and $Hg-Hg_2SO_4$ reference electrode were found to be stable to the irradiation by γ rays. There was the linear relation having several crooks between the decrease of titanium(III) concentration and the quantity of irradiation. The G(Ti^{4+}) value was independent of the initial titanium(III) concentration, sulfuric acid concentration, and irradiation intensity. The G value from the origin to the first crook was 5.76 ± 0.13 except the weak irradiation region. The measurable dose range increased with the elevation of the initial titanium(III) concentration. When the solution of 42 mmole/l was used, the dose of 2×10^6 rad could be measured. The sample solution was reproduced easily by the electrolytic reduction. (auth)

30824 POLYMER PRODUCTION IN THE γ RADIOLYSIS OF METHANE, ETHANE, AND ETHYLENE SOLUTIONS IN LIQUID ARGON. Sheridan, Michael E.; Greer, Edward; Libby, W. F. (Univ. of California, Los Angeles). J. Amer. Chem. Soc.; 94: No. 8, 2614-18(19 Apr 1972).

Further studies of the products of radiolysis of solutions of methane, ethane, and ethylene in liquid argon were made. The additional data seem to show that the most probable mechanism is ionization of the solutes with lowest ionization potential (IP) by electron transfer to the argon ions initially produced by the γ rays and subsequent ion molecule reactions and neutralization to form the heavy hydrocarbons. The limit on molecular weight is suggested to be an energetic one in which further growth of the polymer ion is energetically forbidden. Charge-transfer recharges the polymer when it is neutralized and this is thought to happen several times. (auth)

30825 EFFECT OF ADDITION OF INORGANIC ACIDS OR ALKALIS ON GELATION OF POLYVINYL ALCOHOL AQUEOUS SOLUTION BY γ-RAY IRRADIATION. I. GELATION DOSE. Narasaki, Hisatake (Saitama Univ., Urawa, Japan). Radioisotopes (Tokyo); 21: No. 3, 160-3(Mar 1972).

The effect of addition of inorganic acids or alkalies on gelation of aqueous solutions of poly(vinyl alcohol) by γ-irradiation was studied. The gelation doses decreased with addition of hydrochloric, perchloric, sulfuric, or phosphoric acid, and increased with addition of sodium hydroxide or ammonia water. Acceleration by addition of the acids and the retardation by the alkalies may be explained by increase and decrease of the yield of H radicals from radiolysis of water. (auth)

30826 ONE-ELECTRON REACTIONS IN BIOCHEMICAL SYSTEMS AS STUDIED BY PULSE RADIOLYSIS. V. CYTOCHROME C. Land, E. J.; Swallow, A. J. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Arch. Biochem. Biophys.; 145: 365-72(Jul 1971).

Hydrated electrons react with ferricytochrome c with rate constants ranging from about 2×10^{10} M^{-1} sec^{-1} at pH 6 to about 1×10^{10} M^{-1} sec^{-1} at pH 13. They react at a similar rate with ferrocytochrome c (at pH 7). With ferricytochrome c at pH 7, reduction is followed within 150 nsec by appearance of the characteristic absorption bands of ferrocytochrome c. In alkaline solution, rapid changes occur initially at all wavelengths, but the final ferrocytochrome c absorption spectrum only appears with a half-life of about a tenth of a second at room temperature. The activation energy for this reaction is 20 Kcal per mole. In alkaline solution the rapid Franck–Condon addition of an electron may be assumed to be followed by immediate transfer to iron, after which there is a relatively slow conformational change. The carboxylate radical also reduces ferricytochrome c, with a rate constant around 5×10^8 M^{-1} sec^{-1} above pH 4. Below pH 4 the rate rises by nearly a factor of 10, perhaps because COOH is more reactive than CO_2^-. Below pH 3 the rate falls again. The superoxide anion radical reduces ferricytochrome c with $k = 1.1 \times 10^5$ M^{-1} sec^{-1} at pH 8.5. HO_2 is relatively unreactive. (auth)

30827 CHANGE IN THE HEADSPACE GAS COMPONENTS IN γ-IRRADIATED CANNED AQUEOUS SOLUTIONS OF 5′-IMP. Terada, Junko; Mouri, Takenori; Hata, Keiko; Hashida, Wataru; Shiga, Iwao (Toyo Junior Coll. of Food Tech., Kawanishi, Japan). Toyo Shokuhin Kogyo Tanki Daigaku, Toyo Shokuhin Kenkyusho Kenkyu Hokokusho; No. 9, 231-7(Mar 1970). (In Japanese).

Headspace gas composition contributes information for clarifying the mechanism of deterioration of canned foods and the aspect of can corrosion. The change of headspace gas induced by γ-irradiation in cans containing 5′-IMP solutions was investigated by gas chromatography. Solutions containing 5′-IMP were sealed in plain cans (#2, for baby foods) and irradiated with a 5,000 curie ^{60}Co source at the dose rate of 2.0×10^5 r/hr. The gas samples were injected into Shimadzu GC-IB equipped with columns of silica gel and molecular sieve 5A. Argon was used as the carrier gas. The higher the dose, the lower was the level of remaining 5′-IMP. Oxygen content in headspace decreased, accompanied by marked increase of hydrogen content with increasing γ doses. In canned distilled water, a slight increase in hydrogen gas took place with increasing γ doses. Oxygen gas disappeared during storage for 90 days at 25°C. During storage of irradiated 5′-IMP solutions, the formation of NH_3-N and the dissolution of tin were negligible. Significant amounts of hydrogen gas were formed by irradiation at 4.5 Mrad and disappeared gradually during storage for 90 days. In irradiated solutions of 5′-IMP containing glucose, sucrose, casein hydrolyzate, or sodium chloride, the formation of NH_3N and dissolution of tin and iron were negligible. Remarkable amounts of hydrogen gas were detected in the headspace of irradiated canned 5′-IMP solutions containing glucose, sucrose, or sodium chloride. (auth) (Japan)

30828 FORMATION OF FREE RADICALS IN LOW TEMPERATURE RADIOLYSIS OF THE n-HEPTANE–1-PROPANETHIOL SYSTEM. Tsomaya, N. N.; Bichiashvili, A. D.; Nanobashvili, E. M. (Inst. of Inorganic Chemistry and Electrical Chemistry, Tbilisi, USSR. Tbilisi State Pedagogical Inst., USSR). Soobshch. Akad. Nauk Gruz. SSR; 65: No. 2, 337-40(Feb 1972). (In Russian).

Gamma radiolysis of the n-heptane–1-propanethiol system of various compositions was investigated at 77°K. Radiation yields of G radicals were measured for various concentrations. The decrease of the value of G with the increase of thiol concentration is accounted for by intermolecular processes of the charge transfer to thiol molecules. (auth)

30829 RADIATION CHEMISTRY OF LIQUID METHANOL. I. THE OXIDIZING RADICAL. Dainton, Frederick; Janovsky, I.; Salmon, G. A. (Cookridge Hospital, Leeds, Eng.). Proc. Roy. Soc. (London), Ser. A; 327: No. 1570, 305-16(4 Apr 1972).

Methanolic solutions of I^-, Br^-, Cl^-, SCN^-, and N,N,N′,N′-tetramethyl-p-phenylenediamine (TMPD) were investigated by pulse radiolysis. Except for Cl^- solutions oxidation of the solutes occurs and the transient products I_2^-, Br_2^-, $(SCN)_2^-$ and $TMPD^+$ were identified by their absorption spectra (λ_{max} = 380, 360, 470, and 565 nm respectively). For the Br^- and SCN^- cases the oxidation occurred only in acidified solution. In pure methanol the methoxy radicals react to form the CH_2OH radical. The dependences of the yields of I_2^- and $TMPD^+$ on the concentration of I^- and TMPD respectively indicate that the yield of scavengable methoxy radicals $G(CH_3O) = 2.0$ and that $k(CH_3O + X^-)/k(CH_3O + CH_3OH) = (1.4 \pm 0.1) \times 10^4$. The presence of 0.1 mol $HClO_4$/l or saturation of the solutions with N_2O increases $G(CH_3O)$ by 0.5, an effect which is attributed to methoxy radicals which would otherwise react with electrons within the spurs. Solutions saturated with CO_2 do not show the increased yield. The yield of ethoxy radicals, $G(C_2H_5O)$ derived from measurement of I_2^- formed in ethanolic KI solutions is estimated to be 1.5 ± 0.1. Formate ion was found to have no effect on the yield of I_2^- from methanolic solutions of iodide and it is concluded that the reaction between methoxy radicals and formate ion is slow. (auth)

30830 STUDY OF THE PARAMAGNETIC CENTRES CREATED BY RADIOLYSIS IN K_2CrO_4. Debuyst, R. (Univ., Louvain, Belg.); Apers, D. J.; Capron, P. C. J. Inorg. Nucl. Chem.; 34: No. 5, 1541-50(May 1972). (In French).

Potassium chromate single crystals, which were irradiated at ambient temperature, were analyzed by ESR spectroscopy. On the basis of the g values, of comparisons with published data, and of crystalline geometry considerations, the nature of some paramagnetic centers could be determined as: CrO_4^-, CrO_4^{3-}, CrO_2^-. (auth)

30831 HIGH-INTENSITY RADIOLYSIS OF ARSENITE SOLUTIONS. Muller, J. C.; Ferradini, C.; Pucheault, J. (Centre de Recherches, Ivry, France). Radiochem. Radioanal. Lett.; 10: No. 1, 53-8(14 Apr 1972). (In French).

Acid solutions of sodium arsenite were irradiated by 2-MeV electrons at an intensity of 10^{23} eV · ml^{-3} s^{-1}. Measurement of the yields G(−As(III)) and $G(H_2O_2)$ as a function of arsenite concentration have shown that the sum $G(H_2O_2) + G(-As(III))$ is constant and close to 0.70 at pH = 0.4. At pH = 3.0, the sum is 0.65. A mechanism is proposed, involving oxidation of arsenite by OH radicals and reduction by H radicals. (auth)

30832 NEW PARAMAGNETIC SPECIES FORMED IN γ-IRRADIATED AND ANNEALED FROZEN AQUEOUS ALKALI HYDROXIDE MATRICES. Moorthy, P. N.; Rao, K. N.; Mishra, K. P.; Singh, B. B. (Bhabha Atomic Research Centre, Trombay, India). Radiochem. Radioanal. Lett.; 10: No. 1, 45-51(14 Apr 1972).

The ESR spectra observed in γ-irradiated and annealed frozen aqueous sodium hydroxide matrices were shown to arise from two sources: one due to the species formed from impurities present in the alkali hydroxide used and the other due to the species formed by reaction of dissolved oxygen. The impurity responsible for the former was shown not to be carbonate. From results of experiments in the presence of electron scavengers, it was shown that the species formed by reaction of oxygen is likely to be O_2^- rather than O_3^-. (auth)

30833 PREPARATION OF ^{36}Cl LABELED 2,4,5-TRICHLOROPHENOL BY EXCHANGE WITH H^{36}Cl UNDER ^{60}Co IRRADIATION. Revilla, A. P.; Lubkowitz, J. A.; Parker, W. C. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Radiochem. Radioanal. Lett.; 10: No. 1, 37-43(14 Apr 1972).

The preparation of 2,4,5-trichlorophenol (TCF) labeled with ^{36}Cl is described. The method consists in irradiating a solution of TCF and H^{36}Cl with γ rays. (auth)

30834 γ-RAY INDUCED ADDITION REACTION OF ALIPHATIC ALCOHOLS TO TETRACHLOROETHYLENE. Ymoto, Takaari (Government Industrial Research Inst., Nagoya, Japan); Matsuda, Tatsuo. Nippon Kagaku Kaishi; No. 2, 369-75(Feb 1972). (In Japanese).

Methyl, ethyl, propyl, and butyl alcohols were found to add to tetrachloroethylene as a result of γ irradiation. Saturated and unsaturated 1:1 adducts, whose general formulas were $CHCl_2-CCl_2-C(R_1)(R_2)-OH$ and $CC_2=CCl-(R_1)(R_2)-OH$, were obtained. Effects of molar ratios of reactants, dose rate, total dose, and temperature on this reaction were studied. The optimum conditions were found to be: $(ROH):(CCl_2=CCl_2) = 4:1$, dose rate about 4×10^5 rad/hr, and total dose 4.3 to 7.0 Mrad. Almost all alcohols were found to be consumed at rates nearly proportional to dose rate, but in the case of ethyl alcohol, the rate was found to be nearly proportional to the square root of dose rate. Yields of adducts decreased in the order: ethyl > n-propyl > isopropyl > sec-butyl > methyl > n-butyl > isobutyl. As the total dose increases, the yield becomes higher but the ratio of the yields of unsaturated to saturated adducts becomes large. (auth)

30835 ICE FORMING ABILITY OF γ IRRADIATED AgI PARTICLES. Dobissik, V.; Guenadiev, N.; Levkov, L. J. Rech. Atmos.; 5: No. 3, 127-31(Jul 1971). (In French).

The ability of AgI particles to produce ice is enhanced when the particles are exposed to ^{60}Co γ rays. This fact was demonstrated by cooling large water droplets polluted with nonirradiated and irradiated AgI. The droplets polluted with irradiated AgI freeze at higher negative temperatures. It is hypothesized that the nuclei surfaces acquire new active centers as a result of irradiation. Such modifications are possible throughout the entire AgI system, the most stable among them stimulating the freezing process. (France)

30836 SPECIFICITY OF RADIATION-INDUCED EMULSION POLYMERIZATION OF VINYL CHLORIDE IN THE PRESENCE OF CATIONIC EMULSIFIERS. Smirnov, A. M.; Lukhovitskii, V. I.; Karpov, V. L. Vysokomol. Soedin.; Ser. B; 14: No. 1, 6(Jan 1972). (In Russian).

While investigating the process of radioinduced emulsion polymerization of vinyl chloride in the presence of cationic emulsifiers, it was established that the polymerization rate (at emulsifier concentrations lower than the critical concentration of micelle formation (CCMF)) exceeds the polymerization rate manifested in the presence of surface-active agents (assumed to be equal to the CCMF). Latexes obtained by chemical induction or by uv radiation at cationic emulsifier concentrations above CCMF possess a significant stability. (K.S.W.)

30837 MECHANISMS OF RADICAL FORMATION IN IRRADIATED PURINE BASES AND DERIVATIVES: AN E.P.R. STUDY USING COMPUTER TECHNIQUE. Dertinger, Hermann; Hartig, Gunter (Kernforschungszentrum, Karlsruhe, Ger.). Int. J. Radiat. Biol.; 21: No. 3, 279-92(Mar 1972).

The formation and transformation of radicals induced in dry guanine and adenine and their deoxyribonucleosides and nucleotides by electron irradiation (2 MeV at a dose of 3 Mrads) were studied with Q-band EPR at 77 and 300°K. Two basic mechanisms were derived: decay of the purine ion radicals with release of atomic hydrogen and reaction of the hydrogen atoms with the base moieties to yield the adducts at the positions C_2 and C_8, respectively. (auth) (UK)

30838 RADICAL TRANSFORMATION IN IRRADIATED CYTOSINE AND DERIVATIVES AS STUDIED BY E.P.R. Hartig, G.; Weibezahn, K.; Dertinger, H. (Inst. of Strahlenbiologie, Karlsruhe, Ger.). Int. J. Radiat. Biol.; 21: No. 3, 293-6(Mar 1972).

Radical transformation was studied in dry cytosine, deoxycytidine · HCl, and deoxycytidine-5′-monophosphate (dCMP), irradiated at 77°K with 3 Mrads of 2-MeV electrons. From the differences of the first derivatives of the EPR spectra, measured at 77°K and then at 300°K, it was concluded that the atomic hydrogen originating from the decay of the base ions was involved in the formation of the secondary radicals, the reaction of the hydrogen being facilitated in the direction cytosine → deoxycytidine → dCMP. (UK)

30839 GAMMA AND ALPHA RADIOLYSIS OF AQUEOUS SOLUTIONS OF DIETHYLENETRIAMINEPENTAACETIC ACID. Bibler, Ned E. (E. I. du Pont de Nemours and Co., Aiken, S. C.). J. Inorg. Nucl. Chem.; 34: No. 4, 1417-25(Apr 1972).

The radiolytic destruction of diethylenetriaminepentaacetic acid (DTPA), an eluting agent for the purification of ^{244}Cm by cation exchange chromatography, was studied in H_2SO_4 and HNO_3 solutions. In 0.4M H_2SO_4, DTPA is effectively destroyed by both H atoms and OH radicals. For γ radiation, $G(\text{-DTPA}) = G_H + G_{OH}$; and for α radiation, $G(\text{-DTPA}) = G_H + G_{OH} + G_{HO_2}$. At doses $>10^{21}$ eV/g in solutions less than 4M acid, lanthanide and actinide oxalates precipitate. In ~4M HNO_3 solutions containing >1 g/l. ^{244}Cm eluted from cation exchange columns, the DTPA must be completely destroyed by α-radiolysis before the ^{244}Cm can be concentrated by precipitation with 1M NaOH. At high pH values and in the presence of metal cations that are complexed by DTPA, G(-DTPA) is lowered significantly. Competition studies with various solutes established that OH radicals destroy DTPA effectively ($k = 2 \times 10^9$ M^{-1} sec^{-1}). Failure of excess Br^- ions to lower G(-DTPA) suggests that DTPA can react by a charge transfer mechanism in addition to H atom abstraction. (auth)

30840 CATHODOCHROMISM OF SOME BENZOSPIRAN COMPOUNDS. Ohno, Shin (Japan Broadcasting Corp., Tokyo); Ukita, Yukio. Nippon Kagaku Kaishi; No. 2, 295-301(Feb 1972). (In Japanese).

When 1,3,3-trimethylindolinobenzopyrylspiran and its derivatives ([A]) in polystyrene matrix were bombarded with electron beam of medium energy (5 to 20 keV), two products were formed: a blue or magenta colored [B] and a yellow colored [C]. They returned reversibly to [A] by thermal decoloring. [B] was identical with the photoproduct of the irradiation by ultraviolet light and decayed by the irradiation of visible light. [C] was formed only upon the bombardment. It was more stable than [B] and insensitive to visible light. Crosslinking of polystyrene, the binding matrix, took place by the bombardment, slightly disturbing the coloring and decoloring reactions because of viscosity change. The formation of [C] was promoted when the decoloring reaction of [B] was rapid. So it was suggested that [C] was formed mainly by the bombardment of [B], although the possibility of direct formation of [C] from [A] was not neglected. Moreover, the activated intermediate of polystyrene on the crosslinking participated in the formation of [C]. (auth)

30841 UNSTABLE INTERMEDIATES. PART 112. RADIATION DAMAGE IN PLUMBOUS ACETATE: ELECTRON SPIN RESONANCE SPECTRUM OF A $PbMe^{2+}$ ADDUCT. Booth, R. J.; Starkie, H. C.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., Faraday Trans., II; 68: No. 4, 638-42(1972).

Exposure of plumbous acetate to ^{60}Co γ-rays at 77°K gave a center having $A_{||}(^{207}Pb) = 1928$ G, $A_{\perp}(^{207}Pb) = 1700$ G, $A_{||}(Me) \mp 24$ G, $A_{\perp}(Me) = +20$ G, $g_{||} = 1.953$ and $g_{\perp} = 1.988$. This corresponds to a spin-density of about 60% on lead in an orbital having considerable 6p content. The form of the proton coupling strongly suggests that the coupling is positive and hence the methyl group is probably pyramidal with the unpaired electron in the Pb−C σ^* orbital. Radicals of this class seem to be unprecedented in esr studies. (auth)

30842 UNSTABLE INTERMEDIATES. PART 111. ELECTRON SPIN RESONANCE STUDIES OF γ-IRRADIATED FROZEN AQUEOUS SOLUTIONS OF ALKALI-METAL AZIDES. Ginns, I. S.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., Faraday Trans., II; 68: No. 4, 631-7(1972).

Aqueous glasses containing potassium or sodium azide at 77°K after exposure to ^{60}Co γ-rays had esr spectra containing features characteristic of NH_2 radicals. Exposure to 2537 Å light also gave NH_2 radicals together with an isotropic 5 G triplet characteristic of nitrogen atoms. The NH_2 radicals are probably formed from N_3^{2-} or HN_3^- by loss of nitrogen molecules and protonation of NH^-. This occurs even in glasses containing 10 M alkali hydroxide. (auth)

30843 PULSE RADIOLYSIS OF HEXAMETHYLPHOSPHORIC TRIAMIDE. Nauta, H.; van Huis, C. (Rijksuniversiteit, Utrecht). J. Chem. Soc., Faraday Trans., I; 68: No. 4, 647-52 (1972).

The solvation of electrons in pure hexamethylphosphoric triamide (HMPT) was observed by transient infrared absorption following pulse radiolysis. Addition of biphenyl and anthracene provided evidence of scavengeable electrons, the yield corresponding to a G-value of about 2. The relatively high yield and the very low binding energy of solvated electrons in HMPT are ascribed to the polar and aprotic basic nature of this solvent. (auth)

Radiochemistry and Nuclear Chemistry

Refer also to abstracts 30619, 30745, and 31135.

30844 (AD-734369) CHEMICAL PHENOMENA OF FALLOUT FORMATION. Final Report, May 22, 1970–August 31, 1971. Norman, John H.; Winchell, Perrin; Black, Sandra J. (Gulf General Atomic Co., San Diego, Calif.). 25 Nov 1971. Contract DAHC20-70-C-0388. 23p. (GULF-GA-A-10761). NTIS.

Preliminary results are presented for experiments performed to study five parameters for individual short-lived fission products that are produced by thermal neutron fission in a covered thin-layer source of ^{235}U. These parameters are mass number, half-life, identity of the element, yield, and gamma-ray complement. The nuclides ^{90}Kr, ^{91}Kr, ^{91}Rb, ^{99}Nb, ^{101}Nb, ^{139}Xe, ^{140}Cs, and ^{141}Cs were correlated with a half-life and a probable mass number (or recoil range) of the nuclide giving rise to the gamma ray. (J.G.B.)

30845 APPLICATION OF COMPUTERS TO THE NUCLEAR SCIENCES. Oretga, Ruben F. (Univ. Nacional Autonoma de Mexico, Mexico City). Rev. Mex. Fis., Supl. Fis. Apl.; 20: 81-90(1971). (In Spanish).

A set of computer programs useful in Moessbauer spectrometry, radiochemistry, and activation analysis is described. (auth)

Hot-Atom Chemistry

Refer also to abstract 30815.

30846 CHEMICAL EFFECTS ASSOCIATED WITH ELECTRON CAPTURE AND β^+-DECAY OF $^{57}Ni(II)$. COMPLEXES IN AQUEOUS SOLUTIONS. Omori, Takashi; Wu, Shaw-chii; Tsurumaki, Kunisuke; Shiokawa, Takanobu (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 3: No. 2, 123-31(Dec 1970).

In the solid phase, a relatively large amount of $^{57}Co(III)$ species is found as a result of electron capture and β^+ decay of ^{57}Ni-labeled hexaamminenickel(II) complex. The formation mechanism of the $^{57}Co(III)$ species in the solid phase is rather complicated and cannot be explained simply on the basis of ionization through the Auger cascade. In order to simplify the effects on the formation of the recoil $^{57}Co(III)$ species, an investigation was carried out in aqueous solutions. As the complexing agents, ammonia, ethylenediamine (en), propylenediamine (pn), and ethylenediaminetetraacetic acid (EDTA) were used. (auth) (Japan)

30847 CHEMISTRY OF RECOILING SILICON ATOMS. V. PRODUCT-FORMING REACTIONS IN PHOSPHINE–SILANE MIXTURES. Gaspar, Peter P.; Markusch, Peter; Holten III, J. Dewey; Frost, John J. (Washington Univ., St. Louis). J. Phys. Chem.; 76: No. 9, 1352-65(27 Apr 1972). (COO-1713-24).

Product studies on reactions of recoiling silicon atoms in binary mixtures of phosphine, the silicon precursor, and silane, disilane, and trisilane, respectively, support a mechanism for the product-forming steps involving silylene $^{31}SiH_2$ as the principal reactive intermediate which gives rise to the observed products. In each case the major product is a next-higher homolog of the starting silane, the expected product of Si–H insertion by $^{31}SiH_2$. Four other mechanisms are discussed and rejected on the basis of product studies and scavenger experiments. Competition experiments in ternary phosphine–silane–disilane and quaternary phosphine–silane–disilane–nitric oxide mixtures are correlated by a kinetic scheme for the product-determining steps involving a single intermediate. It is suggested that the product-determining steps are the product-forming steps and that the single kinetically important intermediate is $^{31}SiH_2$. Formation of lower homologs of the major products is explained by the unimolecular dissociation of vibrationally excited silylene insertion products. (auth)

30848 REACTIONS OF ENERGETIC POSITRONIUM ATOMS IN SOLUTIONS. Bartal, Lawrence J.; Nicholas, J. Blair; Ache, Hans J. (Virginia Polytechnic Inst. and State Univ., Blacksburg). J. Phys. Chem.; 76: No. 8, 1125-9(13 Apr 1972).

The lifetime spectra of positrons in solutions of Sn(IV), Sn(II), Pb(II), Cd(II), Zn(II), Tl(I), and Na salts were studied as a function of solute concentration. No significant changes in the two lifetimes, τ_1 and τ_2, observed in these spectra, could be noticed over a wide range of solute concentrations. The corresponding intensities I_2 dropped sharply with solute concentration, eventually leveling off and becoming constant at higher solute concentrations. These saturation values of I_2 are characteristic for each compound and decrease in the order Na > Tl > Zn > Cd > Sn(II) > Pb(II). The data are discussed in terms of a proposed oxidation of "hot" positronium atoms by the solute. (auth)

30849 RECOIL CHEMISTRY OF ^{128}I ATOMS IN SOLID SODIUM IODATE ACTIVATED WITH THERMAL NEUTRONS. Shukla, B. M.; Singh, R. N.; Mishra, S. P. (Banaras Hindu Univ., India). pp 93-9 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

The distribution of ^{128}I activity over the iodide–iodine and iodate fractions was studied. The main activity is found in the iodate fraction with minor contributions in the other fraction. In order to bring out the effect of the irradiation temperature on retention, the crystals were activated at liquid air temperature. The effect of thermal annealing was also studied and the results are discussed. (auth)

30850 ISOTOPIC EFFECT IN THE COLLECTION OF (n,γ) RECOIL PRODUCTS OF BROMINE ON CHARGED PLATES IN BROMOBENZENE. Shukla, B. M.; Mishra, S. P.; Pandey, C. (Banaras Hindu Univ., India). pp 101-11 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

An isotope effect in the collection of recoil bromine species on charged plates in some organic bromides is reported in terms of characteristic values ($\gamma/\sigma n$), which were calculated with the help of cross section (σ), abundance (n), and the yield (γ) of the bromine isotopes collected on the electrodes. To have better results for characteristic values in the organic bromide targets, the ratio of cross sections of ^{80}Br, ^{80m}Br, and ^{82}Br were obtained by comparing the apparent activities developed after irradiating pure liquid bromine with a 300-mc Ra–Be neutron source. These reproducible ratio values were used in the bromobenzene target. The characteristic values obtained are different than the earlier reported values. (auth)

30851 SCAVENGER EFFECT OF BROMINE ON THE REACTIONS OF RECOIL ^{82}Br ATOMS WITH DILUENTS. Mishra, S. P.; Shukla, B. M. (Banaras Hindu Univ., India). pp 113-21 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

Addition of reactive and nonreactive diluents prior to neutron irradiation of alkyl bromides yielded valuable information on the reactions of the recoils. In order to determine the specific reactivity of the diluents (benzene, carbon tetrachloride, and cyclohexane) towards recoil ^{82}Br atoms, scavenger curves were obtained. The results show that benzene stabilizes recoil ^{82}Br atoms mainly by a hot process, whereas the other two diluents act by hot and thermal processes. (auth)

Properties of Radioactive Materials

Refer also to abstracts 30784, 31014, and 31391.

30852 (AAEC/E-220) INFLUENCE OF PRECIPITATION CONDITIONS ON THE PROPERTIES OF AMMONIUM DIURANATE AND URANIUM DIOXIDE POWDERS. Janov, J.; Alfredson, P. G.; Vilkaitis, V. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). May 1971. 40p. Dep. NTIS (U. S. Sales Only).

Factors affecting the properties of ammonium diuranate (ADU) precipitates in relation to the properties of the subsequent UO_2 powders in pellet fabrication are reported and the importance of precipitation parameters demonstrated. Variables investigated include continuous single-versus two-stage precipitation, pH, residence time, washing of ADU to remove nitrate, and calcination-reduction conditions. The most important variable was the pH at which precipitation occurred. This governed the size of agglomerates, which determined the settling and filtering characteristics of the ADU slurry. In two-stage precipitation, the ADU properties were determined by the proportion of uranium precipitated at different pH values. Washing of nitrate from ADU appeared not to affect the properties of the subsequent UO_2 powder. Approximately 75% of the initial nitrate was removed by washing once in demineralized water; more extensive washing caused only a slight further reduction in nitrate content and significantly reduced the filterability of the ADU slurry. When ADU was reduced to UO_2 at 600°C in hydrogen, differences in the surface areas of the powders were markedly reduced but the agglomerate structure of the ADU was retained. ADU that was precipitated mainly at pH 3 to 4, and contained large agglomerates, gave UO_2 containing large agglomerates, which sintered poorly and the pseudomorphs of the large agglomerates were still discernible in the sintered pellets. ADU precipitated at high pH contained small agglomerates and gave UO_2 powder that sintered readily to high-density pellets with uniform microstructure. The settling rate of the ADU slurry gave an early indication of the likely sinterability of the resultant UO_2 powder since both were functions of agglomerate size. Reasonably filterable ADU and sinterable UO_2 powders were prepared via single-stage precipitation at pH 7.2 or by two-stage precipitation in which less than 80% of the uranium was precipitated in the first stage at pH 3.5 and the remainder in the pH range 7 to 8. Less stringent control was required in two-stage precipitation than in single-stage precipitation, but this was offset by the additional complexity of two precipitators and their auxiliaries. (auth)

30853 (AED-C-13-8) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 13. DECONTAMINATION. Philipp, Hermann; Wichmann, Erich (comps.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Dec 1971. 42p. (In several languages). Dep. NTIS (U. S. Sales Only).

Two hundred and sixty-seven references are included, covering the periods 1970 and 1971. Subject, author, report number, and patent indexes are included. (M.C.G.)

30854 (CONF-701148-(Vol.1)) PROCEEDINGS OF THE CHEMISTRY SYMPOSIUM, IIT, MADRAS, NOVEMBER 25–28, 1970. VOLUME I. PHYSICO-CHEMICAL METHODS IN STRUCTURAL INORGANIC CHEMISTRY. (Department of Atomic Energy, Bombay (India). Chemistry and Metallurgy Committee). 336p.

Forty-three papers are included. Separate abstracts were prepared for 11 papers. Two papers were previously abstracted for NSA. For abstracts of these papers see CONF-701148 in the Report Number Index. (M.C.G.)

For abstracts of individual papers see: 30812, 30862–30869, 31413, and 32727.

30855 (INR-P-1360) BASIC STUDIES IN CHEMISTRY OF URANIUM(VI) COMPLEXES. Dembinski, W.; Deptula, A. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 12p. (CONF-700540-6). Dep. NTIS (U. S. Sales Only).

From Polish–Italian seminar on some chemical, ceramic and metallurgical aspects of nuclear fuels; Zakopane, Poland (29 May 1970).

The structures of the complexes of dihydroxyuranyl and uranyl salts with urea and its alkyl derivatives as well as complexes of uranyl cyanate with acetone and uranyl potassium oxycyanate were studied by means of infrared spectroscopy and thermogravimetric analysis. The occurrence of hydrogen bonds between anions and ligands was demonstrated. The relative strength of the UO_2^{2+}-ligand linkage was established. The detailed studies of the course of thermal decomposition of $H_2O \cdot UO_3 \cdot 2CO(NH_2)_2$ were carried out. (auth)

30856 (SZS-19/71 (pp 21-33)) SURFACE DECONTAMINATION WITH A FILM-FORMING DECONTAMINATING AGENT AND COMMERCIALLY AVAILABLE CLEANSING AGENTS. Unger, H. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (In German). Dep. NTIS (U. S. Sales Only).

The composition of film-forming aqueous decontaminating agents, their decontamination efficiency, and applicability as well as the application of the film-forming decontaminating agent ISODEX D are described. Some of the cleansing agents commercially available in the GDR were tested and classified according to their "decontaminating power." (auth)

30857 INVESTIGATION INTO A PHASE DIAGRAM OF THE URANYL–WATER SYSTEM BY MEANS OF TENSIOMETRY. Tsvetkov, A. A.; Seleznev, V. P.; Sudarikov, B. N.; Gromov, B. V. (Moscow Chemical-Technical Inst.). Tr. Mosk. Khim.-Tekhnol. Inst.; No. 67, 65-8(1970). (In Russian).

The uranyl fluoride–water system was investigated by the tensiometric method, and Marshall's solubility diagram was made more precise. The regions of the trihydrate and the tetrahydrate of UO_2F_2 were determined. The curves of limiting solubility of the two solid solutions were plotted for a concentration of UO_2F_2 greater than 95 wt %, and less than 1 mole of H_2O/mole of UO_2F_2. Below 30°C, hydrates with a greater quantity of water than the tetrahydrate do not exist. Consequently, below the solidus line a mixture of ice and tetrahydrate will crystallize out. Between 140.5 and 240°C exists a region of saturated solution in equilibrium with solid solution α. Above 240°C a saturated solution exists in equilibrium with anhydrous uranyl fluoride. (tr-auth)

30858 DIOXO-TRIPROPIONATE-URANATE(VI) OF LITHIUM AND SODIUM. Bermudez Polonio, J.; Rojas Lopez, R. M.; Criado, E. (Instituto de Quimica Inorganica, Madrid). An. Quim.; 67: No. 12, 1193-8(Dec 1971). (In Spanish).

The synthesis, thermal behavior, and x-ray powder data of the hydrated dioxotripropionateuranate(VI) of lithium, $Li[(C_2H_5COO)_3UO_2]xH_2O$, and dioxotripropionateuranate(VI) of sodium, $Na[(C_2H_5COO)_3UO_2]xH_2O$, are described. The complex structure of the salts as well as the character of its water of hydratation are elucidated. (auth)

30859 SPECTROSCOPIC STUDY OF THORIUM(VI) COMPLEXES WITH BIDENTATE SCHIFF BASES. Biradar, N. S.; Kulkarni, V. H. (Karnatak Univ., Dharivar, India). Z. Anorg. Allg. Chem.; 387: No. 2, 275-9(Jan 1972).

The complexes of thorium(IV) chloride with bidentate Schiff bases were prepared. The analytical data indicate 1:2 stoichiometry. The complexes are yellow in color, non-electrolytes in DMF, and appear to be octahedral. The uv, ir, and NMR spectra of the ligands and the complexes are reported. (auth)

30860 CRYSTAL DATA FOR TWO SYNERGISTIC COMPLEXES, $UO_2(TTA)_2TBP$ AND $UO_2(TTA)_2TOPO$. Wong, C. H.; Chen, C. N.; Lu, T. H.; Chao, K. J.; Lee, T. J. (National Tsing Hua Univ., Hsinchu, Taiwan). Z. Kristallogr.; 134: No. 3-4, 320(Nov 1971).

The unit-cell dimensions and space groups were obtained for $UO_2(TTA)_2TBP$ and $UO_2(TTA)_2TOPO$ from oscillation and Weissenberg photographs using CuKα radiation. (D.H.M.)

30861 CHEMISTRY OF OXOURANIUM(V): A NOVEL FREE RADICAL FORMING REACTION. Selbin, J.; Durrett, D. G.; Sherrill, H. J.; Newkome, G. R.; Wharton, J. H. (Louisiana State Univ., Baton Rouge). J. Chem. Soc., Chem. Commun.; No. 7, 380-1(5 Apr 1972).

During a study of the formation and properties of the monoxouranium(v) complexes, a novel reaction leading to the unexpected formation of stable crystalline salts of cationic free radicals of certain heterocyclic nitrogen compounds was discovered. (auth)

30862 CRYSTAL STRUCTURE OF URANYL OXALATE, $UO_2C_2O_4.3H_2O$. Jayadevan, N. C.; Chackraburtty, D. M. (Bhabha Atomic Research Centre, Trombay, India). pp 91-5 of Proceedings of the Chemistry Symposium, 1970. Vol. I. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.1).

Uranyl oxalate, $UO_2C_2O_4 \cdot 3H_2O$, crystallizes as rectangular plates, elongated in the (001) direction. The crystals are monoclinic with lattice parameters a = 5.623, b = 17.065, c = 9.451 Å, and β = 98.74(1)°. The space group is $P2_{1/c}$ with four formula units per cell. A total of 673 reflections was estimated visually on equi-inclination photographs, and the structure refined by Fourier and 3-dimensional least-squares methods to an R value of 0.120. Each uranium atom exists as a linear $(O-U-O)^{2+}$ ion with five secondary oxygen atoms coordinated to it. These oxygen atoms belong to two oxalate groups and one water molecule. Two other water molecules are not coordinated to the uranium atoms. The structure is consistent with the thermal behavior of uranyl oxalate where two water molecules are lost below 100°C while the third is lost only at 170°C. The bond distances and the nature of bonding are discussed. (auth)

30863 ABO_3 TYPE STRUCTURES OF ACTINIDES. Awasthi, S. K.; Dias, R. M. A.; Chackraburtty, D. M. (Bhabha Atomic Research Centre, Trombay, India). pp 97-103 of Proceedings of the Chemistry Symposium, 1970. Vol. I. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.1).

The compounds of the type ABO_3 having perovskite structure have been widely reported in literature. A brief review is made about perovskite actinide compounds and the ordering of the B cations in such structure is discussed. When the B cation is replaced by a suitable combination of two cations B & B′ in 1:1 atom ratio the ordering could result as in the case of $A_2BB'O_6$ type compounds. By varying the ratio of B(U^{6+} or U^{4+}) cation and B′ (rare earths or Zr, Ti, etc.) to the ratio of 1:2 uranium compounds of the type $A_3BB'_2O_9$ were prepared and one reported. X-ray diffraction patterns revealed that ordering of B and B′ atoms did not take place and the phases could be indexed on the basis of a pseudocubic lattice corresponding to ABO_3 structure. (auth)

30864 THERMOCHEMISTRY AND STRUCTURAL ASPECTS OF INNER COMPLEXES. Sundaresan, M. (Bhabha Atomic Research Centre, Trombay, India). pp 177-89 of Proceedings of the Chemistry Symposium, 1970. Vol. I. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.1).

The enthalpies of combustion, formation, and vaporization of acetates of copper(I), copper(II), beryllium, calcium, magnesium, chromium(II), chromium(III), thorium, and uranium(VI), of magnesium benzoate, of zirconium mandelate, as well as of salicylates of magnesium, aluminum, etc., were determined by the techniques of bomb calorimetry, reaction calorimetry, and isoteniscopy. The data available from literature in combination with the experimental values were used to form empirical Born Haber cycles from which were computed the values of heats of chelations of these compounds in the gaseous state. The values of heats of chelation in the condensed phases were then calculated by forming suitable cycles. The coordinate metal–oxygen bond energies were then determined by equating the values of the heats of chelation in the gaseous phase to the summation of the bond formation and dissociation energies. As was expected, these bond energies were found to be strongly dependent on the metal ion. The transferability of these bond energies from one compound to another was established and it was shown that these can be used as a secondary path for conforming and elucidating the structure of inner complexes. (auth)

30865 METAL-HALOGEN VIBRATIONAL FREQUENCIES OF SOME FLUOROCOMPLEXES OF URANIUM(IV). Satapathy, K. C.(Univ. of Sambalpur, Burla, India); Sahoo, B. pp 289-92 of Proceedings of the Chemistry Symposium, 1970. Vol. I. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.1).

The infrared stretching vibration ν(U–F) of a number of fluoro complexes of uranium(IV) were studied. The most obvious generalization that can be made about the results is that all the compounds believed to possess the stoichiometry $M^+(UF_5^-)$ show the ν(U–F) band in the region 460 to 470 cm^{-1}. For compounds possessing the stoichiometric ratio $M^{2+}:U^{4+}:F^-$ 1:1:6, the ν(U–F) band is lowered by 40 to 59 cm^{-1} implying increased coordination number for uranium(IV) ion (M^+ and M^{2+} represent organic substituted mono and diammonium ion, respectively). (auth)

30866 MAGNETIC PROPERTIES, ELECTRONIC SPECTRA, AND INFRARED SPECTRA AS AIDS IN THE STRUCTURAL STUDIES OF SOME DIOXOURANIUM(VI) COMPLEXES. Majumdar, A. K.; Bhattacharyya, R. G. (Jadavpur Univ., Calcutta). pp 293-8 of Proceedings of the Chemistry Symposium, 1970. Vol. I. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.1).

Because of f electron involvement in the bonding the uranyl(VI) ion is feebly paramagnetic in some isolated quinoline N-oxide, diphenyl sulfoxide, and triphenyl phosphate complexes. The molar susceptibility and the asymmetric stretching frequency (ν_3) of the uranyl(VI) ion are compared and both the parameters depend on the multiplicity of UO bond. The ν_3 and κ_M of uranyl(VI) ion are dependent on the electronic interaction of the latter with other anionic ligands when organic ligand is fixed, whereas a change in the organic ligand needs take cognizance of both electronic and vibrational interactions. In the cationic complexes the parameters are higher than those observed in anionic complexes and the reasons for this are discussed. From the rigorous Gaussian analysis of the electronic spectral bands, the components of $T \leftarrow S$ transitions and the vibrational intervals are found and an attempt is made to interpret the structure of uranyl(VI) ion in the excited state. (auth)

30867 THALLIUM DIOXOURANIUM(VI) CARBOXYLATES AND BASIC DIOXOURANIUM(VI) FORMATE. Aravamudan, G.; Sampath, S. (Indian Inst. of Tech., Madras). pp 299-305 of Proceedings of the Chemistry Symposium, 1970. Vol. I. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.1).

Normal and basic double acetates and formates featuring thallium(I) and dioxouranium(VI) and basic dioxouranium(VI) formate were prepared and characterised by x-ray diffraction and ir spectroscopy. Thermolysis of the double formates and acetates ultimately yielded thallium diuranate in both cases but the intermediate processes were greatly different. Basic dioxouranium(VI) formate on heating in air yielded $\alpha-UO_3$ without the intermediate formation of lower valent uranium compounds. (auth)

30868 COMPLEXES OF URANYL-β-DIKETONES WITH AROMATIC AMINE-N-OXIDES. Subramanian, M. S.; Manchanda, V. K. (Bhabha Atomic Research Centre, Trombay, India). pp 307-12 of Proceedings of the Chemistry Symposium, 1970. Vol. I. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148– (Vol.1).

A series of complexes of uranyl β-diketones with pyridine-N-oxide (PyNO) and its 4-substituted derivatives (4z · PyNO) were isolated by solvent extraction. The β-diketones used were thenoyl trifluoroacetone (TTA), benzoyltrifluoroacetone (BTFA), benzolyacetone (BA), dibenzoylmethane (DEM), trifluoroacetylacetone (TFAA), and hexafluoroacetylacetone (HFAA); the 4-substituents of the amine N-oxide ranged from the electron-withdrawing NO_2 and Cl to the electron-releasing CH_3 and OCH_3 groups. The analytical data for these complexes lead to their formulation as $UO_2(\beta\text{-diketone})_2S$ where S = PyNO or 4z · PyNO. They are monomeric in benzene and nonelectrolytes. Characteristic infrared stretching frequencies and proton magnetic resonance spectra of the complexes are reported and discussed in relation to the substituent parameter (σ^+) of the amine N-oxide. (auth)

30869 INNER COMPLEX COMPOUNDS OF URANYL CHLORIDE WITH AROMATIC SCHIFF BASES. Biradar, N. S.; Goudar, T. R.; Mahale, V. B.; Kulkarni, V. H.; Pujar, M. A. (Karnatak Univ., Dharwar, India). pp 321-5 of Proceedings of the Chemistry Symposium, 1970. Vol. I. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.1).

A few Schiff base complexes of uranyl chloride were prepared by reacting uranyl chloride with aromatic Schiff bases in ethyl acetate medium. The complexes are dark colored and amorphous. The analytical data indicate either 1:1 or 1:2 stoichiometry depending on the nature of the ligand. The structure of the complexes was determined with the help of conductometric and infrared studies. (auth)

30870 DETERMINATION OF ABSOLUTE DISINTEGRATION RATES OF BETA EMITTERS. Ramaswami, A.; Dange, S. P.; Prakash, Satya; Ramaniah, M. V. (Bhabha Atomic Research Centre, Bombay). pp 123-30 of Proceedinggs of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

Absolute disintegration rates of beta emitters are usually determined using 4π beta and 4π beta–gamma coincidence counting techniques. Since these are not so convenient for day-to-day routine counting, gas-flow proportional counters used for routine counting were calibrated by making use of the measurements made on 4π beta and 4π beta–gamma coincidence counters. The efficiencies of gas-flow beta proportional counters are now available for a large number of fission product nuclides. Details of these measurements are described. (auth)

30871 SOLUBILITY OF CeF_3 IN MOLTEN MIXTURES OF LiF, BeF_2, AND ThF_4. Sood, D. D.; Iyer, P. N.; Prasad, R.; (and others) (Bhabha Atomic Research Centre, Bombay). pp 355-62 of Proceedings of-the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

Equipment was set up to study the solubility of PuF_3 in ternary solvent mixtures of $LiF-BeF_2-ThF_4$ that may be used to fuel a plutonium start-up molten salt breeder reactor. The solubility of CeF_3 tagged with ^{144}Ce as a stand-in for PuF_3 in $LiF-BeF_2-ThF_4$ (66.5, 19, 14.5 m%) was determined in the temperature range 550 to 800°C. Sintered copper filter sticks were used to withdraw salt samples from the CeF_3 saturated melts and the samples were analyzed by radiochemical and wet chemical methods. The data are represented by a least square line of log (solubility) vs 1/T plot, the slope of which gave the heat of solution of CeF_3 as 12.7 kcal/mole. The data were compared with the values recently reported for nearest solvent compositions. (auth)

30872 SOME CONSIDERATIONS IN HIGH SPECIFIC ACTIVITY TRACE LABELLING OF ORGANIC COMPOUNDS OF MEDICAL INTEREST. Mani, R. S.; Desai, C. N.; Prabhakaran, R. J. V.; Raghavan, S. V.; Balakrishnan, S. A. pp 373-82 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.2).

Compounds in which radioisotopes of an element replace stable isotopes of the element and compounds in which radioisotopes replace chemically analogous elements or different elements completely are discussed. General considerations in labeling compounds are discussed. Specific compounds labeled with iodine or mercury are considered. (M.C.G.)

30873 EQUATIONS OF STATE FOR UF_6 FOR A WIDE RANGE OF STATE PARAMETERS. Malyshev, V. V. At. Energ. (USSR); 32: No. 4, 313-14(Apr 1972). (In Russian).

The compressibility of UF_6 was measured over a wide density range at intervals of 0.1 g/cm³ up to 3.417 g/cm³. The temperature range of 364 to 592.2°K, liquid-vapor equilibria, and pressures up to 242 bars were included in this study. Equations of state that describe the saturated vapor pressure, and the densities of the vapor and the liquid, respectively, are given. (K.S.W.)

30874 DIFFERENTIAL GAS ANALYSIS METHOD: APPARATUS AND ITS APPLICATIONS. Mizutani, Nobuyasu; Kitazawa, Akio; Kato, Masanori (Tokyo Inst. of Tech.). Nippon Kagaku Kaishi; No. 1, 81-7(Jan 1972). (In Japanese).

The apparatus, which was developed to study the solid-state reactions and physicochemical changes involving absorption or evolution of gases, consists of a modified gas effluent analysis equipment and a high-precision gas mixer. The apparatus in more useful in the fields of inorganic chemistry, organic chemistry, metallurgy, etc., than a conventional EGA equipment. The sample is heated or cooled at a constant rate in a mixed flow of two or more different gases such as $He-O_2$, $He-CO_2$, $Ar-H_2$, etc. The changes in the composition of the gas passing through the reactor due to decomposition or the gas−solid reaction are detected with high sensitivity by a thermal conductivity detector. The sample weight required for the usual measurement is 5 to 50 mg. It is applicable to the range from room temperature to 1600°C and the gas flow of any mixing ratio (200 : 1 to 1 : 200). Although the limits of determination are affected by the operating conditions, an evolution or absorption of 0.01 to 0.0001 ml of oxygen by the sample in the $He-O_2$ mixture can be detected. The apparatus may be applied to the following reactions: reduction of vanadium pentoxide by hydrogen, thermal decomposition of calcium oxalate monohydrate, oxidation and reduction of iron oxide, formation and decarbonation of calcite, and hydrogenation and formation of uranium hydride. (auth)

30875 CRYSTAL STRUCTURE OF BIS(TETRAETHYLAMMONIUM) OXOPENTACHLOROPROTACTINATE(V). Brown, D.; Reynolds, C. T.; Moseley, P. T. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc., Dalton Trans.; No. 7, 857-9(1972).

A three-dimensional structure analysis of the title compound showed it to be the first example of a protactinium (V) compound to contain a protactinium−oxygen double bond (Pa = O 1.74 Å). Crystals are monoclinic, space-group Cc, with Z = 4 in a unit cell of dimensions: $a_0 = 14.131 \pm 0.008$, $b_0 = 14.218 \pm 0.008$, $c_0 = 13.235 \pm 0.009$ Å, and $\beta = 91.04° \pm 0.03°$. The structure was solved by conventional Patterson and Fourier methods and refined by least-squares techniques to R 6.7% for 558 independent reflections. The oxygen and five chlorine atoms form a distorted octahedron around the protactinium atom; Pa−Cl distances range from 2.42 to 2.72 Å. (auth)

30876 INFRARED SPECTRUM OF TRIPOTASSIUM URANYL FLUORIDE. Ohwada, Ken; Soga, Takesi; Iwasaki, Matae (Japan Atomic Energy Research Inst., Tokai). Spectrochim. Acta, Part A; 28: No. 5, 933-8(May 1972).

The infrared absorption spectrum of tripotassium uranyl fluoride ($K_3UO_2F_5$) was observed in the frequency region 4000 to 30 cm^{-1}. A normal coordinate analysis of the $(UO_2F_5)^{3-}$ anion, neglecting K^+ ions, was carried out using Wilson's FG matrix method. On the basis of the results of this treatment, six of the nine bands observed for $K_3UO_2F_5$ are reasonably assigned either to the i.r.-active fundamentals or to i.r.-active combination tones for the inner $(UO_2F_5)^{3-}$ anion. The other three bands are assigned tentatively to the lattice vibration modes of outer K^+ ions with inner $(UO_2F_5)^{3-}$ anion. Brief discussions are also given on the force constants obtained for the U−O and U−F bonds in the $(UO_2F_5)^{3-}$ anion. (auth)

30877 REDUCTION OF THE MERCURIC ION INDUCED BY THE PHOTOLYSIS OF THE URANYL-ORGANIC SYSTEMS. Matsushima, Ryoka; Sakuraba, Shukichi (Shizuoka Univ., Hamamatsu, Japan). J. Amer. Chem. Soc.; 94: No. 8, 2622-5(19 Apr 1972).

Reduction of the mercuric ion induced by the photoredox reactions of the uranyl−organic systems was studied both in aqueous and in 10% polyvinyl alcohol (PVA) solutions with the irradiation of $\lambda \geq 3650$ Å at room temperature. It appeared that the mercuric ion was reduced by the intermediate species formed in the primary photoredox reaction between the excited uranyl ion and ethanol. The formation of the uranium(IV) was completely inhibited by the mercuric ion, while acetaldehyde formation was not retarded. The molar ratios were $[U(IV)]/[\text{aldehyde}] = 0$, and $-\Delta[HgCl_2]/[\text{aldehyde}] = 2$, for the deoxygenated aqueous solutions. The reaction in the viscous PVA solution led to a uniform suspension of mercurous chloride, and the change in its optical density was followed with the time of irradiation. The mercuric reduction was also found in the photoredox reactions of other systems than the ethanol−uranyl system. The high photosensitivity suggested utility for a photographic process. (auth)

30878 OLEFIN SELECTIVITY FOR THE DEHYDRATION OF 2-OCTANOL BY ALUMINA AND THORIA. Davis, Burtron H. (Potomac State Coll., Keyser, W. Va.). J. Org. Chem.; 37: No. 8, 1240-4(21 Apr 1972).

The primary olefin distribution was determined for the dehydration of 2-octanol over several alumina and thoria catalysts. Rather than attempt the elimination of secondary reactions, the isomerization of a very similar olefin, 1-heptene, was used to determine the extent of isomerization of the primary olefin products. For acidic alumina the initial olefin products were 45% 1-octene, 5% trans-2-octene, and 50% cis-2-octene. The presence of alkali metals in the alumina to decrease acidity caused an increase in the amount of the trans isomer and a corresponding decrease in the 1 isomer. (auth)

30879 PRACTICAL RADIATION PROTECTION IN THE ISOTOPES LABORATORY: MONITORING AND PROTECTION PROCEDURES FOR SAFE HANDLING OF RADIOISOTOPES IN TYPE B AND C LABORATORIES. Maushart, R. G-I-T (Glas- Instrum.-Tech.) Fachz. Lab.; 14: Nos. 10-12, 1153-4; 1157-9; 1285-6; 1289-92; 1411-12; 1415-17(1970). (In German).

Properties of low-energy β emitters; organization of protective measures; measurement of contamination on surfaces, on the person, and in the air; decontamination and its measurement; and the relevant apparatus that should be available in laboratories of types B and C are discussed. (Anal. Abstr.)

30880 EQUILIBRIA OF THORIUM(IV) WITH MONOCARBOXYLATE LIGANDS. Portanova, R.; Tomat, G.; Cassol, A.; Magon, L. (CNR, Padua. Univ., Catania, Italy). J. Inorg. Nucl. Chem.; 34: No. 5, 1685-90(May 1972).

The complex formation of thorium(IV) with monochloroacetate, formate, β-chloropropionate, acetate, butyrate, isobutyrate and propionate was studied by means of potentiometric $[H^+]$ measurements. The stability constants were determined in aqueous solution with 1M $NaClO_4$ at 20°C. The relationship between the stability of the thorium complex and the dissociation constant of the carboxylic acid corresponding to the respective ligand anion is discussed. (auth)

30881 NEPTUNYL(VI) COMPLEXES WITH GLYCOLATE IN AQUEOUS SOLUTION. Portanova, R.; Tomat, G.; Magon, G.; Cassol, A. (CNR, Padua). J. Inorg. Nucl. Chem.; 34: No. 5, 1768-70(May 1972).

The nature and the stability constants of the glycolate complexes formed in neptunyl(VI) solutions were studied and the stability constants of the analogous complexes of UO_2^{2+}, NpO_2^{2+}, and PuO_2^{2+} were compared. The formation of the neptunyl(VI)-glycolate complexes in aqueous solution was studied by determining the concentration of the free ligand by means of potentiometric $[H^+]$ measurements. All the measurements were made in 1M $NaClO_4$ solution and at 20°C. The results are tabulated and indicate that the tendency of the oxycations to form complexes with glycolate is in the order $UO_2^{2+} > NpO_2^{2+} > PuO_2^{2+}$ and that the UO_2^{2+} and NpO_2^{2+} complexes are appreciably stronger than the corresponding PuO_2^{2+} complexes. (UK)

30882 SPECTROPHOTOMETRIC STUDY OF THE FORMATION OF AMERICIUM THIOCYANATE COMPLEXES. Harmon,

H. D. (Univ. of Tennessee, Knoxville, Oak Ridge National Lab., Tenn.); Peterson, J. R.; Bell, J. T.; McDowell, W. J. J. Inorg. Nucl. Chem.; 34: No. 5, 1711-19(May 1972).

The results of a spectrophotometric study of the formation of Am(III) thiocyanate complexes at an ionic strength of 1.0 M enabled calculation of $\beta_1 = 5.79$ ($\sigma = 0.33$) and $\beta_2 = 6.77$ ($\sigma = 1.05$) for $Am(SCN)^{2+}$ and $Am(SCN_2^+$, respectively. Additional studies of Am(III) in KSCN solutions of variable ionic strength suggested that Am(III) is strongly complexed and provided qualitative evidence for the existence of anionic complexes in 5 to 10 M KSCN. The "effective stability constant" approach was applied to the data at low KSCN concentrations to calculate $\beta_1^* = 7.6$ ($\sigma = 2.5$) for $Am(SCN)^{2+}$. (auth)

30883 OVERALL STABILITY CONSTANT OF THE COMPLEX $UO_2(CO_3)_3{}^{4-}$. O'Cinneide, S.; Scanlan, J. P.; Hynes, M. J. (University Coll., Galway, Ireland). Chem. Ind. (London); No. 8, 340(15 Apr 1972).

The stability constants for the various carbonato complexes of UO_2^{2+} are defined as, $\beta_{n(c)} = [UO_2(CO_3)_n^{2-2n}]/[UO_2^{2+}][CO_3^{2-}]^n$ where n = 1, 2 or 3. Of these the tricarbonato complex, $UO_2(CO_3)_3^{4-}$ is the most important, since it is as this species that uranium exists in some natural aqueous media, and in carbonate-leach liquors from uranium ores. The value $\log \beta_{3(c)} = 21.57 \pm 0.02$ was obtained for the complex $UO_2(CO_3)_3^{4-}$ from partition data obtained with systems containing varying concentrations (0.025−0.1M) of HOX, varying concentrations (0.02−0.08M) of H_3A at pH's 6.0−8.0, and varying concentrations of carbonate ion at pH 9.0. (auth)

30884 HYDROLYSIS OF Pu^{4+}. Metivier, H.; (Laboratoire de Radiotoxicologie, Montrouge, France); Guillaumont, R. Radiochem. Radioanal. Lett.; 10: No. 1, 27-35(14 Apr 1972). (In French).

Hydrolysis constants for Pu^{4+} were calculated by solvent extraction of Pu(IV) in the system ($HClO_4-LiClO_4-\mu = 1$ TTA or DBM-benzene) with ^{238}Pu. Analysis of the distribution coefficient with a computer gives: $\log K_1 = -0.45$, $\log K_2 = -0.75$, $\log K_3 = -3.3$, $\log K_4 = -6.3$. The conditions for stability of the tetravalent state of plutonium in this system were found and the extraction of plutonium(IV) by HIPT in benzene was studied. (auth)

30885 PROGRAMS FOR RESOLUTION OF COMPLEX SPECTRA. APPLICATION TO THE ABSORPTION SPECTROPHOTOMETRY OF TRANSURANIUM ELEMENTS. Carlier, J. (Institut du Radium, Paris). Radiochem. Radioanal. Lett.; 10: No. 1, 19-26(14 Apr 1972). (In French).

Two programs were written for the precise calculation of the position and optical density of each band of an absorption spectrum, even in the case of overlapping bands. Spectra of neodymium and neptunium(IV) and (V) have been taken as examples. (auth)

30886 THEORY OF LINEAR TRANSPORT OF URANIUM IN THE IODIDE PROCESS. Hashino, Tomoyasu (Kyoto Univ.); Kawai, Takeshi. Nippon Kagaku Kaishi; No. 2, 248-53(Feb 1972). (In Japanese).

A fundamental consideration of the iodide process of uranium in a closed system is presented on the basis of nonequilibrium thermodynamics. In order to simplify the treatment, the model of the discontinuous system consisting of two large reservoirs connected by a small transport path was employed. Conditions for the mass transport between both sub-systems, i.e., a reaction zone and a deposition zone, in which several chemical reactions take place, are related to the thermodynamic forces of the system. The rate of chemical transport of uranium is represented by the chemical potential difference of the iodide taking part in the transport, or by the chemical affinity of the rate-determining step of the reaction. The present theory is applicable to other iodide processes such as niobium. (auth)

30887 CRYSTALLOGRAPHIC STUDY OF $Rb_3UO_2F_5$. Brusset, H.; Nguyen Quy Dao; Rubinstein-Auban, A. (Ecole Centrale des Arts et Manufactures, Chatenay-Malabry, France). J. Inorg. Nucl. Chem.; 34: No. 5, 1575-80(May 1972).

$Rb_3UO_2F_5$ crystallizes in the tetragonal lattice with the space group $14_1/a$. The dimensions of the cell are $a = 9.53_8$ Å; $c = 18.57_3$ Å. Most of the crystals formed are twinned. One type of the twin observed is described. The compound is isostructural with $K_3UO_2F_5$. (auth)

30888 STUDIES ON CUBIC MAGNESIUM URANATE, $Mg_yU_{1-y}O_{2+x}$. II. STRUCTURAL ANALYSIS. Fujino, Takeo (Japan Atomic Energy Research Inst., Ibaraki). J. Inorg. Nucl. Chem.; 34: No. 5, 1563-74(May 1972).

The structural problems in cubic magnesium uranate, $Mg_yU_{1-y}O_{2+x}$, were studied. From measurements of density variation with oxygen concentration, the oxygen nonstoichiometry in this compound was assigned to the interstitial oxygen and not to the metal vacancy formation. The observed x-ray intensity of Bragg peak was found to decrease far more rapidly with y in $Mg_yU_{1-y}O_{2+x}$ in dilute range than expected from the simple theoretical model for substitutional solid solution. This discrepancy may be interpreted by the large distortion of uranium ions around a magnesium impurity ion. The B value of thermal vibrations was observed by x-ray measurements to be 0.2 to 0.3 Å^2 over the y range from 0 to 0.24. A measure of static distortion, δa, was obtained by the integral breadth method. The variation of δa with y was discussed in connection with the decrease of peak intensity. (auth)

30889 CRYSTAL STRUCTURE AND LATTICE PARAMETERS OF ^{248}Cm OXYCHLORIDE, $^{248}CmOCl$. Peterson, J. R. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 34: No. 5, 1603-7(May 1972).

The oxychloride of curium was prepared on the microgram scale with long-lived curium-248 ($t_{1/2} = 3.5 \times 10^5$ yr) and found to exhibit the PbClF-type, tetragonal structure. Room temperature, average lattice parameters were determined to be $a_0 = 3.985 \pm 0.003$ Å and $c_0 = 6.752 \pm 0.008$ Å, where the error limits represent the 95% confidence level calculated using the standard statistical method for the average of seven independent determinations. (auth)

30890 SYSTEM URANYL SULPHATE–WATER. II. PHASE RELATIONSHIPS AND THERMOCHEMICAL PROPERTIES OF THE PHASES IN THE SYSTEM $UO_3-SO_3-H_2O$. Cordfunke, E. H. P. (Reactor Centrum Nederland, Petten). J. Inorg. Nucl. Chem.; 34: No. 5, 1551-61(May 1972).

Several uranyl sulphate hydrates were found in the $UO_2SO_4-H_2O$ system, either by dehydration of the stable hydrate $UO_2SO_4 \cdot 2\frac{1}{2}H_2O$, or by dehydration of the metastable hydrate $UO_2SO_4 \cdot 3\frac{1}{2}H_2O$. Their phase relationships were examined by investigation of the ternary systems $UO_2SO_4-H_2SO_4-H_2O$ and $UO_2SO_4-UO_3-H_2O$, and by examining their thermal stability. X-ray powder data and heats of formation of these phases are presented. In addition one acid and two basic uranyl sulphate hydrates were found in these systems, one of the latter being the naturally occurring mineral uranopilite. Finally, the $\alpha-\beta$ phase change in anhydrous UO_2SO_4 was investigated by high-temperature x-ray diffraction. The influence of small amounts of free sulphuric acid on the crystallization and formation of these phases is demonstrated. (auth)

30891 TETRAD EFFECT: THE THIOCYANATE COMPLEX STABILITY CONSTANTS OF SOME TRIVALENT ACTINIDES. Harmon, H. D. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.); Peterson, J. R.; McDowell, W. J.; Coleman, C. F. J. Inorg. Nucl. Chem.; 34: No. 4, 1381-97(Apr 1972).

A solvent extraction technique, using bis(2-ethylhexyl) phosphate as the extractant, was employed to examine the formation of Am(III), Cm(III), Bk(III), Cf(III), and Es(III) thiocyanate complexes in a $NaSCN-NaClO_4$ medium at ionic strength I = 1.0 M and pH = 2.00. Mathematical analysis of the data led to the conclusion that the mono-, di-, and trithiocyanate species exist in the thiocyanate concentration range studied. Values of the overall stability constants β_1, β_2, and β_3 were calculated. As the atomic number of the actinides increased, the β_1 values exhibited a gradual increase in stability, which is consistent with the expected effect on complex stability due to the actinide contraction. The β_2 values decreased rapidly across the series from americium to einsteinium, with a concomitant increase in β_3. In addition, there was evidence of the tetrad effect in the β_3 values, and this led to the tentative conclusion that the $Act(SCN)_3$ (where Act = Am, Cm, Bk, Cf, and Es) complexes are of the inner-sphere type. The thermodynamic parameters of the Am(III) thiocyanate complexes were calculated from temperature dependence measurements. The enthalpy and entropy changes were used to aid in the distinction between inner-sphere and outer-sphere complex formation. (auth)

30892 KISLORODNYE SOEDINENIYA URANA. PROTSESSY DISSOTSIATSII, OKISLENIYA I VOSSTANOVLENIYA. (Oxygen Compounds of Uranium. Processes of Dissociation, Oxidation, and Reduction). Vlasov, V. G.; Zhukovskii, V. M.; Tkachenko, E. V.; Beketov, A. R. Moscow; Atomizdat (1972). 256p.

This monograph focuses attention on the physicochemical properties of uranium oxides and phase relationships in the system uranium−oxygen. Thermodynamic analyses are presented for the processes of dissociation and reduction of uranium oxides by various reducing agents. The kinetics and mechanism of the oxidation of uranium metal and its lower oxides are considered in detail. Successive chapters are devoted to the action of H_2, NH_3, CO, CH_4, and various forms of solid carbon on the higher oxides of uranium. Problems in macro- and micro-kinetics of certain reactions, fundamental chemical diffusion theory of heterogeneous reactions, and structural and phase conversions are analyzed. (tr-auth)

30893 PEROVSKITE PHASES IN THE SYSTEM BaO$-$RE$_2$O$_3$$-UO_{2,x}$ WITH RE = RARE EARTHS, La AND Y. I. COMPOUNDS OF THE COMPOSITION Ba$_2$RE$_{0.67}$UO$_6$ AND Ba$_2$RE$_{0.67}$UO$_{5.5}$. Kemmler-Sack, S.; Hofelich, I. (Laboratorium fuer Anorganische und Analytische Chemie, Tuebingen, Ger.). Z. Anorg. Allg. Chem.; 388: No. 1, 4-28(Feb 1972). (In German).

In the BaO$-$RE$_2$O$_3$$-UO_{2,x}$ system the formation of polymorphically ordered perovskites Ba$_2$RE$_{0.67}$UO$_6$ was observed. On reduction, the ordered perovskites Ba$_2$RE$_{0.67}$UO$_{5.5}$ are formed, which contain U(V) only. According to the results of magnetic and spectroscopic investigations the pentavalent uranium occupies the centers of slightly or strongly distorted octahedrons, while U(VI) forms UO$_2^{2+}$ groups. The rare earths are always present in the trivalent state. The structural relations to the ordered perovskite A$_2$BB$'$O$_6$ are discussed. (auth)

30894 PEROVSKITE PHASES IN THE SYSTEM BaO$-$RE$_2$O$_3$$-UO_{2,x}$ WITH RE = RARE EARTHS, La, AND Y. II. COMPOUNDS OF THE COMPOSITION Ba$_2$(RE$_{0.67}$U$_{0.33}$)UO$_{6.17}$. Kemmler-Sack, S.; Hofelich, I. (Laboratorium fuer Anorganische und Analytische Chemie, Tuebingen, Ger.). Z. Anorg. Allg. Chem.; 388: No. 1, 29-42(Feb 1972). (In German)

In the BaO$-$RE$_2$O$_3$$-UO_{2,x}$ system the formation of compounds Ba$_2$(RE$_{0.67}$U$_{0.33}$)UO$_{6.17}$ was observed. They crystallize in a pseudocubic ordered perovskite lattice, and contain tetravalent and pentavalent uranium in the ratio 1 : 3. Their magnetic and spectroscopic properties are reported. (auth)

30895 STABILIZATION OF DIVALENT CALIFORNIUM IN THE SOLID STATE: CALIFORNIUM DIBROMIDE. Peterson, J. R. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.); Baybarz, R. D. Inorg. Nucl. Chem. Lett.; 8: No. 4, 423-31(Apr 1972).

The preparation of CfBr$_2$, the first known compound of divalent californium, is reported. Individual cation exchange resin beads, saturated with 1 to 5 μg of ^{249}Cf, were calcined in air. The resulting californium oxide samples were transferred into quartz capillaries and treated with anhydrous HBr at 500 to 625°C. CfBr$_3$ was formed in this reaction. The CfBr$_2$ samples were prepared from CfBr$_3$ by hydrogen gas reduction at ~650°C. X-ray diffraction studies were made on the sample. (M.C.G.)

30896 BINDING OF DIVALENT METAL IONS BY A PHOSPHORYLATED ION-EXCHANGE RESIN. Horyna, J.; Vesely, V. (Inst. of Nuclear Research, Rez, Czech.). J. Inorg. Nucl. Chem.; 34: No. 5, 1739-47(May 1972).

The interactions of a phosphorylated ($-$PO$_3$H$_2$) ion-exchange resin with Ca^{2+}, Zn^{2+}, Cu^{2+}, and UO$_2^{2+}$ ions were measured potentiometrically in 0.15M KNO$_3$ solution at 25°C. Linear plots of $-\log[\mathrm{H}^+]$ vs. $\log \alpha/(1-\alpha)$ were obtained in both the absence and the presence of divalent metal ions for both exchangeable hydrogen atoms. The calculated metal complex equilibrium constants increase in the order $\mathrm{Ca}^{2+} < \mathrm{Zn}^{2+} < \mathrm{Cu}^{2+} < \mathrm{UO}_2^{2+}$. The dependence of the equilibrium constants on the resin loading is discussed. (auth)

Radioactive Waste Treatment

Refer also to abstracts 30761, 30763, 31042, and 31621.

30897 (BNWL-B-122) PILOT PLANT VITRIFICATION OF SIMULATED ALPHA-CONTAINING ALKALINE WASTE. Kaser, J. D. (Battelle Pacific Northwest Labs., Richland, Wash.). Aug 1971. Contract AT(45-1)-1830. 13p. Dep. NTIS.

Pilot plant tests demonstrated that simulated sludge could be converted to an insoluble glass within 304L stainless steel storage containers. The molten waste did not corrode the containers significantly. During the melting process some dust, NO, and water vapor are evolved. An off-gas condenser is probably not necessary, but a scrubber may be required to remove dust and NO. The melt is fluid and should be adaptable to intermittent discharge from a crucible into an unheated container. (auth)

30898 GLASS-FIXATION OF RADIOACTIVE WASTES. Schiewer, E.; Lutze, W.; Heimerl, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Glastech. Ber.; 44: No. 9, 377-8 (1971). (In German).

Filtrolit-glasses (boron silicate glasses) with varying B$_2$O$_3$ content were tested with respect to their leaching as well as crystallization behavior. The sodium selfdiffusion in glasses and crystallization products was also studied. (INIS)

30899 STUDY OF GLASS SYSTEMS WITH SrO AS THE MAIN CONSTITUENT. Zagar, L.; Lueneberg, H. (Technische Hochschule, Aachen). Glastech. Ber.; 44: No. 9, 345-53(1971). (In German).

Glass systems with high SrO content were investigated as to their suitability for storing fission products of nuclear fuels, and for certain scientific and technological purposes. As the investigations were chiefly concerned with glass technology, radiation properties received little attention. The investigations were based on the system SrO$-$Na$_2$O$-$B$_2$O$_3$$-ZrO_2$$-TiO_2$$-SiO_2$ because these oxides have the greatest effects on the required glass properties. The limits of glass formation in the systems SrO$-$Na$_2$O$-$SiO$_2$, SrO$-$B$_2$O$_3$$-SiO_2$, SrO$-Al_2O_3$$-SiO_2$, and SrO$-Al_2O_3$$-B_2O_3$$-SiO_2$ were determined; an SrO content of 65 mole % was possible in the latter of these. In the course of these investigations, about 170 combinations were melted and examined with regard to melting behavior, devitrification, corrosiveness, fluidity, density, and chemical durability. Unsuitable compositions were not further considered, but promising compositions were tested to determine more precisely density, chemical durability in water, leaching out of Sr, thermal expansion, transformation point, Littleton softening point, and viscosity$-$temperature relation. (INIS)

30900 RECOVERY OF PROMETHIUM FROM FISSION PRODUCT WASTES. PART II. Chandrasekharan, E. S.; Shukla, J. P.; Rengan, K. (Bhabha Atomic Research Centre, Trombay, India). pp 157-63 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.2).

A simple procedure for recovery of Pm from fission product waste solution obtained in the nuclear fuel reprocessing was developed. The attractive feature of the proposed scheme is that only a very few cheap and easily available chemicals are required, which may possibly make it adaptable for plant-scale operations. Preliminary purification of Pm from associated fission products is readily accomplished by a MnO$_2$ column. Recovery of Pm from a synthetic mixture containing long-cooled fission product solution and required inactive carriers equivalent to those expected to be present in a fuel reprocessing waste solution containing 1 curie of Pm (1000 MW/D ton irradiation) was about 80% and considerably high decontamination factors for beta and gamma were obtained. Additional advantages are: recovery of Pm from the eluate is quite easy and to increase product purity the Pm fraction can be conveniently recycled. (auth)

30901 FIXATION STUDIES OF FISSION PRODUCT ELEMENTS AND URANIUM OF INORGANIC EXCHANGERS. Murthy, T. S.; Balasubramanian, K. R.; Ananthakrishnan, M.; Varma, R. N.; Mathai, C. (Bhabha Atomic Research Centre, Bombay). pp 171-7 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.2).

Various inorganic exchangers such as zirconium phosphate, ammonium phosphomolybdate, ammonium phosphotungstate, polyantimonic acid, and phosphoantimonic acid were studied. The methods of preparation of these exchangers with reproducible exchange characteristics were worked out. Fixation studies were carried out with radioactive tracers both by batch equilibration and column techniques. The breakthrough capacities for the elements of interest were subsequently checked using simulated fission product solutions having different compositions. A feasible scheme of fixation of long-lived fission product elements on the inorganic exchangers was developed. (auth)

30902 SOME STUDIES ON RUTHENIUM SORPTION BY LEAD DIOXIDE AND LEAD MANGANESE DIOXIDE. Jha, J. C. (Bhabha Atomic Research Centre, Bombay). pp 189-95 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.2).

Ruthenium sorption on lead dioxide and lead manganese dioxide (LMO) was investigated under static conditions with ^{106}Ru tracer as the nitrosyl nitrate complex in nitric acid. The effects of various parameters, such as aging of the solution, concentration of nitric acid, pH, contact time, etc., were studied to characterize the nature of ruthenium species present in the solution. Comparative sorption tests with cerium, cesium, and strontium are also presented. LMO was found to be more effective than lead dioxide for removal of ruthenium. However, both the sorbents lacked affinity for cesium and strontium. Cerium was sorbed to a small extent. It is possible, therefore, to separate ruthenium alone from the mixed fission products in high concentrations of nitric acid. The selectivity of the sorbent for ruthenium, combined with its high density and stability in nitric acid, will find applications in treatment of radioactive effluents wherein the presence of ruthenium poses a problem. (auth)

30903 REMOVAL OF METHYL IODIDE BY IMPREGNATED CHARCOALS FROM FLOWING AIR UNDER HUMID CONDITION. Kitani, Susumu (Japan Atomic Energy Research Inst., Tokai); Noro, Tadami; Kohara, Takaaki. J. Nucl. Sci. Technol. (Tokyo); 9: No. 4, 197-202(Apr 1972).

The trapping of methyl iodide from flowing humid air by impregnated charcoals was studied with regard to chemical reactions between methyl iodide and impregnants. Twenty-seven compounds for impregnation on activated charcoal were tested. Stannous iodide and potassium thiocyanate were found to be the most effective, as well as potassium iodide and triethylenediamine, for the removal of methyl iodide in flowing steam–air systems. The characteristics of the base material for impregnation and the surface properties of the impregnated charcoals are also discussed. (auth)

30904 EXPERIMENTAL STUDIES ON DISPOSAL OF RADIOACTIVE WASTES. RECOVERY BY SEPARATION OF A PARTICULAR ION (^{137}Cs) BY COAGULATION-PRECIPITATION AND ION EXCHANGE. Horioka, Masakazu (Yamagata Prefectural Inst. of Public Health, Japan). Gesuido Kyokai-Shi; 8: No. 83, 15-26(Apr 1971). (In Japanese).

A-Floc shows an excellent turbidity removal effect for radioactive wastes of low or high turbidity. However, the rate of removal of ^{137}Cs by coagulation and precipitation is less than 10% though satisfactory floc is formed. Consequently, it is not possible to remove ^{137}Cs with the A-Floc. However, about 95% is removed if the waste solution is treated with clay mineral powder with high CEC content prior to the treatment with A-Floc. Zeolite shows excellent ion exchange ability to Cs ions. By the use of zeolite, it is possible to remove Cs ions selectively from a mixture of various ions. When radioactive wastes are treated with the A-Floc at first and then with the zeolite, more than 90% of the Cs is removed from the wastes. The amount of radioactivity of ^{137}Cs exchanged by 1 kg zeolite is equivalent to about ^{60}Co 5,000 Ci. The zeolite used for this ion exchange can be used as a radioactive source as it is. It is also possible to elute Cs by the use of elutriate such as ammonium chloride. (Japan)

Radioisotope Production

Refer also to abstracts 30767 and 30839.

30905 (IAEA-TA–545) RADIOISOTOPES PRODUCTION. Report to the Government of the Philippines. Panek, K. (International Atomic Energy Agency, Vienna (Austria)). May 1970. 11p. INIS.

Activities at the Philippine Atomic Research Center in 1968-69 are described. The following problems are considered: introducing new methods for ^{32}P production and construction of the appropriate production unit; production of ^{32}P colloidal chromium phosphate; production of ^{203}Hg labeled compounds; improving the production unit for ^{131}I; preparation of ^{131}I sodium o-iodohippurate; introducing new methods for standardization of ^{35}S; design of a new tray for beam post irradiation; putting into operation the 400-channel pulse height analyzer; and some health safety improvements. (INIS)

30906 (IAEA-TA–546) RADIOISOTOPE PRODUCTION. Report to the Government of Greece. Hayes, T. (International Atomic Energy Agency, Vienna (Austria)). 20 May 1970. 14p. INIS.

Activities in the Democritos Nuclear Research Center, Athens, Greece, in the period 1966-70 are described. The following problems are discussed: modifications of iodine-131 cells and target decanning cells; improvement of ventilation systems and other health safety measures; planning of the chemical and biological control laboratories; recruitment and training of the radioisotope production staff; introducing the production of ^{99m}Tc and ^{198}Au (colloidal); and building of the dispensing and sterilization facilities. (INIS)

30907 (IAEA-TA–562) RADIOISOTOPE PRODUCTION. Report to the Government of the Republic of Korea. Lundstroem, R. A. (International Atomic Energy Agency, Vienna (Austria)). 28 Jul 1970. 8p. INIS.

Activities in the Korean Atomic Energy Research Institute, center for isotope production, are described and improvements suggested. These improvements concern mainly safety measures in laboratories, purity of raw materials, quality control, organization of isotope service, etc. ^{131}I, ^{32}P, colloidal ^{198}Au and ^{99m}Tc are now produced in good quality. Some measures for new laboratories under construction are recommended. (INIS)

30908 (JEN–231-DQ/I-80) APPLICATION OF SPECTROGRAPHIC ANALYSIS TO THE RADIOISOTOPE PRODUCTION CONTROL. Capdevila, C.; Roca, M. (Junta de Energia Nuclear, Madrid (Spain)). 1972. 17p. (In Spanish). Dep. NTIS (U. S. Sales Only).

The copper spark technique was employed for both semi-quantitative and quantitative determinations of twelve usual impurities in the ppM range, in solutions of ^{54}Mn, ^{55}Fe, ^{59}Fe, and ^{51}Cr. The effect of the HCl concentration has previously been investigated: for the majority of elements the line intensities attain a maximum at 0.3 N HCl. To compensate for the influence of the concentration of the radioactive element, as well as of Na in the ^{51}Cr samples, Bi, Ga, In, Mo, Pd, Tl and Y were tested. Finally, the quantitative determination of each radioelement was performed using the above-mentioned elements as internal standards, Ga and Mo giving the best results. (auth)

30909 (N–72-11605) CYCLOTRON PRODUCTION OF ^{123}I: AN EVALUATION OF THE NUCLEAR REACTIONS WHICH PRODUCE THIS ISOTOPE. Sodd, Vincent J.; Scholz, Kenneth L.; Blue, James W.; Wellamn, Henry N. (Bureau of Radiological Health, Rockville, Md.). Oct 1970. 45p. (NASA-TM-X–67336; BRH/DMRE–70-4). NTIS.

The reactions studied, which produce ^{123}I directly, were ^{121}Sb(^{4}He,2n)^{123}I, ^{121}Sb(^{3}He,n)^{123}I, ^{122}Te(d,n)^{123}I, ^{122}Te(^{4}He,p2n)^{123}I, ^{122}Te(^{3}He,pn)^{123}I, and ^{123}Te(^{3}He,p2n)^{123}I. Reactions that produce ^{123}I indirectly through positron decay of 2.1-hour ^{123}Xe were ^{122}Te(^{4}He,3n)^{123}Xe, ^{122}Te(^{3}He,2n)^{123}Xe, and ^{123}Te(^{3}He,3n)^{123}Xe. Use of the gas-flow ^{123}I cyclotron target assembly is recommended for the production of ^{123}I with radiochemical purity greater than 99.995%. (auth) (STAR)

30910 APPLICATION OF SPECTROGRAPHIC ANALYSIS TO THE CONTROL OF RADIOISOTOPE PRODUCTION. II. ANALYSIS OF SOLUTIONS OF ^{45}Ca, ^{46}Sc, ^{63}Ni, AND ^{64}Cu. Capdevila Perez, C.; Roca Adell, M. (Junta de Energia Nuclear, Madrid). An. Quim.; 67: No. 1, 25-36(1971). (In Spanish).

Quantitative and semi-quantitative analysis of each radioisotope solution (in which both the radioactive element and the primary element are determined) was carried out by means of the copper-spark technique for all the elements named except Cu, for which silver or graphite electrodes were used. Inter-element effects and their compensation with various reference elements were examined, good results being obtained with Li for Ca; Y for Sc, Ti, and Ni; and either In or Y for Cu and Zn. (Anal. Abstr.)

30911 PREPARATION OF WEIGHTLESS CALIFORNIUM SOURCES. Sivaramakrishnan, C. K. (Bhabha Atomic Research Centre, Trombay, India). pp 165-70 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

Nanogram amounts of ^{252}Cf were recovered from a ruptured nickel foil of 0.005 mil thickness on which this isotope had been deposited. In order to standardize a method for the preparation of weightless californium sources the following methods were investigated: careful evaporation on a gold-plated mylar film and electrodeposition from a single aqueous drop, organic medium, a macro aqueous medium. Two thin sources of the californium-252 sources were prepared by electrodeposition on 0.5-mil-thick nickel foil from saturated ammonium chloride medium. Spectra of kinetic energies of fission fragments of this spontaneously fissioning isotope indicated that these sources are comparable to the original sources. (auth)

30912 PREPARATION OF ^{52}Fe FOR MEDICAL USE, PRODUCED BY CYCLOTRON-BOMBARDMENT. Akiha, Fumimasa (Hirosaki Univ., Japan); Aburai, Tamaru; Nozaki, Tadashi; Murakami, Yukio. Radioisotopes (Tokyo); 21: No. 3, 155-9(Mar 1972). (In Japanese).

The preparation of ^{52}Fe, on a practical scale for medical use, by He bombardment of natural chromium using the 160-cm cyclotron was developed. The target consists of a $2 \times 7 \times 0.05$ cm^{3} layer of pure chromium electroplated onto pure copper backing plate ($5 \times 9 \times 1$ cm^{3}). A 2-hr bombardment at 40 MeV and a beam current of 20 μA yields about 2 mCi of ^{52}Fe at the end of bombardment. After 1 to 5 hr bombardment, the chromium layer was dissolved into 130 to 150 ml of 9N hydrochloric acid (80°C). Then the solution was transferred into a separating funnel, into which O_2 gas was bubbled for about 5 min. Then 1 ml of Br_2-water was added and the bubbling continued for 3 to 5 min to complete the oxidation of ^{52}Fe(II) to ^{52}Fe(III). From the resulting hydrochloric acid solution (8 N), the ^{52}Fe(III) was extracted with two 80-ml portions of isopropyl ether. The ether layers were combined and the $^{52}FeCl_3$ was back-extracted with two 30- to 50-ml portions of distilled water. Then the ^{52}Fe(III) was reduced to ^{52}Fe(II) with 5 to 6 mg of ascorbic acid and finally a ^{52}Fe(II) citrate solution was prepared for medical use. Thus the ^{52}Fe was obtained in sufficient radiochemical and chemical purity, within about 1 hr, and the total yields proved to be 90 to 92%. The specific activities for 2 to 3 mCi of ^{52}Fe were determined 20 to 30 μCi/μgFe. (auth)

30913 QUANTITIES AND UNITS USED IN THE PRODUCTION OF RADIONUCLIDES BY CHARGED PARTICLE BOMBARDMENT. Lebowitz, E. (Brookhaven National Lab., Upton, N. Y.). Int. J. Appl. Radiat. Isotop.; 23: No. 4, 203(Apr 1972).

In replying to the letter by Svoboda and Silvester (Int. J. Appl. Radiat. Isotop.; 22, 269–70(1971)) (NSA 25: 32008) the author agrees that the "production rate" R is a better quantity to use than the "thick target yield" but considers that R is still an oversimplification in relationship to the best quantity for use in expressing radionuclide production by charged particles. (UK)

30914 RECOVERY OF ^{241}Am FROM A WASTE SOLUTION OF PLUTONIUM PURIFICATION. Akatsu, Johkun; Ishimori, Tomitaro (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 4, 237–40(Apr 1972).

Americium-241 was recovered by coprecipitation from an aqueous solution discarded after the purification of 50 g of plutonium. Incidental plutonium, which had leaked out from the purification processes, was also recovered. The aqueous waste solution (30 l) was made alkaline by adding an excess of calcium hydroxide. Plutonium and ^{241}Am were carried with a fresh precipitate of calcium hydroxide and separated from each other by ion exchange. Approximately 30 mg of ^{241}Am and 2g of plutonium were recovered. The yields were about 80% for both ^{241}Am and plutonium. The salt solution after the recovery was converted to solid waste and discarded. (auth)

Reactor Fuel Reprocessing

Refer also to abstracts 30782, 31037, 31618, 31627, and 32751.

30915 (ARH–2334) SELECTIVE DISSOLUTION OF URANIUM FROM FUEL FABRICATION SCRAP. Panesko, J. Vincent (Atlantic Richfield Hanford Co., Richland, Wash.). Mar 1972. Contract AT(45-1)-2130. 10p. Dep. NTIS.

Uranium was preferentially dissolved from unsintered plutonium–uranium fuel fabrication scraps. Trace levels of dissolved plutonium were recovered by anion exchange. These processes were not applicable to sintered scrap containing solid solutions of PuO_2-UO_2 in which plutonium dissolved with uranium. (auth)

30916 (CEA-Bib–201) FLUORIDE AND OXYFLUORIDE Ru COMPOUNDS. Valladon, Michel; Bourgeois, Michel (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar 1972. 32p. (In French). Dep. NTIS (U. S. Sales Only).

Fluorides and oxyfluorides of ruthenium are reviewed. A description is given for each of these compounds of preparations and physical and chemical properties. These properties are listed in order to understand the behavior of ruthenium in a fluoride volatility process. (auth)

30917 (DOCKET-50201–117) WEST VALLEY REPROCESSING PLANT. Low Level Liquid Waste Treatment Facility, Summary Report No. 5. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 14 Apr 1972. 29p. Dep. NTIS.

Plant performance, radioactivity releases, resin usage, and process modifications are discussed. ^{137}Cs, ^{90}Sr, gross β, and ^{106}Ru releases are reported. (M.C.G.)

30918 (DOCKET-50201–118) WEST VALLEY REPROCESSING PLANT. Safety Analysis Report on Intercycle Evaporation. (Nuclear Fuel Services, Inc., Rockville, Md.). Apr 1972. 47p. Dep. NTIS.

To improve the recovery and the purification of the uranium, a proposal was made to install an evaporative system between the partition cycle and first U cycle and between the first and second U cycles. The evaporators will concentrate the uranyl nitrate from about 60 to about 256 g U/l. The criticality safety of this proposed addition to the uranium purification system was evaluated for the maximum reactive process stream of 5 wt % ^{235}U-enriched uranyl nitrate solution. This maximum process stream has a uranium concentration of 900 g U/l, which far exceeds the design maximum concentration of 256 g U/l. The process modifications were found to be critically safe. (M.C.G.)

30919 (DOCKET-50201–119) WEST VALLEY REPROCESSING PLANT. Return of One Metric Tonne of Irradiated Uranium Contained in NPR Failed Fuel Assemblies. (Nuclear Fuel Services, Inc., Rockville, Md.). 8 May 1972. 2p. Dep. NTIS.

30920 (DOCKET-50268–28) MIDWEST FUEL RECOVERY PLANT. Review of Some Points Discussed Following Inspection on March 22, 1972. (Paducah Gaseous Diffusion Plant, Ky.). 25 Apr 1972. 2p. Dep. NTIS.

30921 (ORNL–4746) CALCULATION OF THE TRANSIENT BEHAVIOR OF A DILUTE-PUREX SOLVENT EXTRACTION PROCESS HAVING APPLICATION TO THE REPROCESSING OF LMFBR FUELS. Groenier, W. S. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 60p. Dep. NTIS.

A method for calculating the time-dependent behavior of countercurrent solvent extraction processes was applied to a dilute-Purex flowsheet proposed for use in the recovery of spent Liquid–Metal-Cooled Fast Breeder Reactor (LMFBR) fuels. This effort led to the development of a computer program, SEPHIS, which employs a combination of approximate mathematical equilibrium expressions and the transient, stagewise process calculational method to allow the prediction of stage and product stream concentrations with accuracy and reliability. The applications of SEPHIS to process analysis and control, criticality analysis, and inventory control for nuclear safeguards purposes are particularly intriguing. (auth)

30922 (ORNL–TM–3579) DESIGN AND COST STUDY OF A FLUORINATION–REDUCTIVE EXTRACTION–METAL TRANSFER PROCESSING PLANT FOR THE MSBR. Carter, W. L.; Nicholson, E. L. (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 84p. Dep. NTIS.

A preliminary design study and cost estimate were made for an integrated processing plant to continuously treat irradiated $LiF-BeF_2-ThF_4-UF_4$ fuel salt from a 1000-MW(e) single-fluid, molten salt breeder reactor. The salt is treated by the fluorination–reductive extraction–metal transfer process to recover and recycle uranium and carrier salt, to isolate ^{233}Pa for decay, and to concentrate fission products in waste media. For a plant that processes the active inventory (1683 ft^3) of reactor fuel on a 10-day cycle the direct costs were estimated to be $21 million and indirect costs were $15 million for a total investment of $36 million. Allowances for site, site preparation, and buildings plus facilities shared with the reactor are not included since these costs are included in the overall cost of the power station. The net fuel cycle cost for processing on a 10-day cycle at 80% plant factor was estimated to be 1.1 mills/kWhr; this includes credit for a 3.3% yr yield of bred fuel. The capital investment was not strongly influenced by processing rate. A plant to process the 1000-MW(e) reactor on a 3.3-day cycle was estimated to cost $48 million. A 0.9-gpm stream of fuel salt flows directly from the reactor to the processing plant, and, after about 30 minutes holdup for decay of short-lived fission products, the salt flows to a fluorinator where approximately 95% of the uranium is removed. The salt is then contacted with bismuth containing metallic lithium reductant to extract ^{233}Pa and the remaining uranium, which are hydrofluorinated from the bismuth into a captive salt phase and held for ^{233}Pa decay. The U- and Pa-free salt is treated in a second extractor with additional Bi–Li solution to remove most of the rare earth fission products, which are isolated via the metal transfer operation in Bi–Li alloys and held for decay. Finally, the rare earths are hydrofluorinated into a waste salt for disposal. Fuel salt is reconstituted by reducing recycle UF_6 from the fluorinator directly into the purified $LiF-BeF_2-ThF_4$ carrier. Gaseous reaction products (HF and excess H_2) from UF_6 reduction are treated to remove volatile fission products and recycled. A portion of the HF is electrolyzed to provide F_2 for fluorination. Reductive extraction and metal transfer operations are carried out at about 640°C; fluorination and hydrofluorination can be conducted at 550 to 600°C. Molybdenum is the assumed construction material for vessels that contained molten bismuth and bismuth–salt mixtures; Hastelloy N was used for vessels containing only molten fluoride salt. (auth)

30923 (SRO–122(Pt.2)) PLANT COSTS BREAKDOWN BY PROCESS STEP FOR SPENT FUEL PROCESSING PLANT, NUCLEAR FUEL SERVICES, INC., CATTARAUGUS COUNTY, NEW YORK. PART II. (Bechtel Corp., San Francisco, Calif.). 21 Jun 1966. Contract AT(38-1)-407. 34p. Dep. NTIS. For Nuclear Fuel Services, Inc., West Valley, N. Y.

The costs included under the individual column headings and the principles followed in allocating the indirect costs are defined. (M.C.G.)

30924 REPROCESSING OF IRRADIATED NUCLEAR FUELS. Geier, H. (Lurgi-Gesellschaft fuer Chemotechnik mbH, Frankfurt am Main). Metallgesellschaft; No. 13, 50–8(1970). (In German).

A general survey is given on the importance and necessity of reprocessing of nuclear fuels and on the process itself and its technology. The reprocessing plant WAK in Karlsruhe, Germany is described. Costs and future technological development of reprocessing plants are discussed. (INIS)

30925 METHOD OF PROCESSING NUCLEAR FUELS. Avogadro, A.; Wurm, J. (to European Atomic Energy Community). Canadian Patent 890,837. 18 Jan 1972. Priority date 25 Oct 1968, Netherlands.

Irradiated nuclear fuel containing uranium and plutonium can be processed by converting the uranium to a plutonium-containing alkali metal uranate suspended in a molten salt or salt mixture at temperatures up to 450°C. The melt is treated with gaseous hydrogen chloride and oxygen to separate the dissolved uranium from the undissolved plutonium compounds. The salt mixture may consist of a eutectic mixture of lithium chloride and potassium chloride. (Canada)

30926 METHOD OF IMPROVING RECOVERY OF NEPTUNIUM IN THE PUREX PROCESS. Swanson, John L. (to United States Atomic Energy Commission). U. S. Patent 3,652,233. 28 Mar 1972. Filed 29 Dec 1969.

The recovery of neptunium values from the Purex Process for reprocessing irradiated nuclear reactor fuel was improved by adding a rate-accelerating material to increase the rate of oxidation of the neptunium in the nitric acid solution in the first extraction column. The rate-accelerating material is formed by adding 1-nitropropane to a sodium hydroxide solution to form the aci-form of nitropropane, then adding sodium nitrite and acidifying the solution by the addition of nitric acid. (Official Gazette)

30927 REPROCESSING A PLUTONIUM DIOXIDE-MOLYBDENUM FUEL. Nelson, Paul A.; Wenz, Donald A. (to United States Atomic Energy Commission). U. S. Patent 3,647,421. 7 Mar 1972. Filed 4 Apr 1969.

Plutonium is recovered from an oxidation-resistant plutonium dioxide–molybdenum fuel by reacting the fuel with molten cupric chloride contained in a molten salt to form a soluble plutonium species, an insoluble molybdenum species, and a volatile molybdenum species. Plutonium is reduced and separated from the cupric chloride by mixing the salt with a zinc–magnesium or a cadmium–magnesium alloy, which is thereafter retorted to leave essentially pure plutonium metal. (Official Gazette)

30928 IMPROVEMENTS IN OR RELATING TO THE TRANSFERENCE OF CARBON FROM ONE ZONE TO ANOTHER ZONE. (to SNAM Progetti SpA). British Patent 1,269,743. 6 Apr 1972. Priority date 21 Jan 1969, Italy.

A method is proposed for transferring carbon from a first zone of a closed system to a second zone of the same system. It can be applied to the reprocessing of fuels from a nuclear reactor, i.e., the separation of carbon from small spheres of U, Pu, or Th fuel. Carbon is reacted with a carrier fluid compound (gaseous CO_2, H_2, or steam), the resulting carbonaceous compound (CO, CH_4, or CH_4, respectively) is transferred to a second zone, and temperature and pressure are adjusted so that with the aid of a catalyst carbon is deposited. Catalysts used in depositing carbon from CO are Co, Ni, or Fe; for the cracking of CH_4, either Fe, Pt, Co, Ni, Al, or Mg may be used. (J.G.B.)

30929 OBSERVATIONS ON THE PROCESS CHEMISTRY OF NEPTUNIUM. Srinivasan, N.; Ramaniah, M. V.; Patil, S. K.; (and others) (Bhabha Atomic Research Centre, Trombay, India). pp 363-6 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

Neptunium is extracted almost quantitatively in the first cycle of the Purex Process, whereas its extraction is reduced to about 50% in the second cycle. To explain this behavior, the oxidation state analysis of neptunium, before and after nitrite conditioning, of the first cycle feed was carried out. Neptunium exists mainly as Np(V). An attempt was made to explain the path of neptunium in the plutonium plant. Distribution coefficient data for Np(IV) and Np(VI) in 30% TBP–Shell–sol T from 1 to 4M HNO_3 and 0 to 80% uranium saturation of the 30% TBP at 45 and 60°C were obtained. The distribution coefficient of Np(VI) decreased with increasing temperature, whereas for Np(IV) the behavior was reversed. (auth)

30930 COUNTER-CURRENT EXTRACTION STUDIES FOR THE RECOVERY OF NEPTUNIUM BY PUREX PROCESS. Srinivasan, N.; Ramaniah, M. V.; Kumar, S. V.; (and others) (Bhabha Atomic Research Centre, Trombay, India). pp 367-71 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

Using a 12-stage mixer-settler unit conditions for coextraction of Np(VI) and Np(IV) into 30% TBP–SST at the organic phase uranium loading of 80 to 90 g/l were established. As it was proposed to recover neptunium from the raffinate of the uranium purification cycle in the Purex Process, experiments were carried out to force Np(IV) into the raffinate. With 1M HNO_3 in the feed and the scrub and uranium loading of 90 g/l in the organic phase, it was observed that Np(IV) gets refluxed in the unit. With 2M HNO_3 in the feed and the scrub, Np(IV) is quantitatively extracted with uranium, and the extracted Np(IV) can be partitioned from uranium with an additional scrub of 1 or 0.5M HNO_3. (auth)

30931 FUEL REPROCESSING IN FLUORO-NITRIC MEDIA. Ballet, Paul; Faugeras, Pierre; Isaac, Michel; Lefort, Guy; Miquel, Pierre (to Commissariat a l'Energie Atomique). French Patent 2,074,812. 8 Oct 1971. Filed 30 Jan 1970. (In French).

A process for avoiding the corrosive action of fluorine during the concentration by evaporation of aqueous solutions containing fission products is described. A refluxing circulation of aluminum nitrate complexes the fluorine in the evaporating vessel. The aluminum nitrate (in solution form) is introduced into the upper part of the column, which rises above the concentrator of the aqueous fission product solutions. The column and concentrator form an enclosure within which the evaporation is performed. (France)

ENGINEERING

Energy Conversion

30932 (AED-CONF-71-100-15) STATUS REPORT ON INVESTIGATIONS OF THE APPLICABILITY OF MHD GENERATORS IN NUCLEAR POWER PLANTS IN THE FEDERAL REPUBLIC OF GERMANY. Bohn, Th. (Kernforschungsanlage, Juelich (West Germany)); Brederlow, G. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). May 1971. 15p. (CONF-710901-520). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The possibility of using MHD generators in conjunction with gas or steam turbines to increase the electric power generating efficiency of nuclear power plants is discussed and current research studies at the Max Planck Institute for Plasma Physics and at Juelich are described. It is concluded that while important engineering and technological problems have been solved in large-scale test rigs and major progress has been made in the fields of high-temperature materials technology, seed material extraction, gas purification, and the thermodynamics of the process, certain essential questions such as the performance of the generator at high pressure, the development of nuclear reactors with sufficiently high gas outlet temperatures, and the possibility of achieving high enough magnetic fields remain unanswered. Therefore, a great deal of physical and technical research is still needed to prove whether a rare gas MHD generator can be operated economically. Should these problems be solved, the application of MHD generators in nuclear power plants would be a significant economic advance. (L.C.L.)

30933 (CEA-R-4272) IMPROVEMENTS IN THE ELECTROMECHANICAL CONVERSION OF ENERGY USING SHOCK WAVES. Landure, Yves (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Feb 1972. 57p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Lyon Univ., France.

Aspects of electrical mechanical conversion are discussed. Results of a study are presented in which such conversion was obtained by the depolarization of a ferroelectric ceramic. The shock wave which produces depolarization is created by gun powder. The speed of the projectile is measured and the pressures generated in the ceramic are determined graphically. The energy is released on a linear resistive load. It is shown by different parameters how to obtain the maximum electrical energy. On a resistive load of 26 ohms, energy of 0.91 J/cm^3 was released in less than 0.5 μs corresponding to an electrical horsepower higher than 2 MW/cm^3. (auth)

30934 (WASH-1199) DEVELOPMENT OF A HIGH VOLTAGE HEAT PIPE THERMIONIC MODULE. Final Technical Report, October 1, 1969–June 30, 1971. Longsderff, R. W. (RCA Corp., Lancaster, Pa. Industrial Tube Div.). Jul 1971. Contract AT-(30-1)-4161. 62p. Dep. NTIS.

Research directed toward the design, fabrication, and testing of a 5V 10 diode heat pipe thermionic module is reported. It was found that the development of the internally series connected module concept appears to be a basis for obtaining an output voltage of approximately 28 volts in advanced modules. While the concept was not proven through the actual operation of the working model, development of the key module components, such as the integral emitter/collector tri-layer assembly and arc suppression coating, has shown the feasibility of the concept. The development of a lithium heat pipe for distribution of the input thermal power has also been shown. The concept design should be modified to gain further thermal stress relief in the collector-to-collector interconnection ring joint to permit E-B welding without risking the integrity of the arc suppression coating. The design might also be modified to permit a stepped approach of emitter to heat pipe assembly in order to eliminate the risk of molybdenum-to-molybdenum seizure during assembly. (J.R.D.)

30935 EFFECTS OF CHANNEL SIZE ON THE IONIZATION INSTABILITY IN MHD GENERATORS. Evans, Robert Michael. Stanford, Calif.; Stanford Univ. (1971). 134p. University Microfilms Order No. 72-11,544.

Thesis.

An experimental and theoretical study of the ionization instability in nonequilibrium, continuous-electrode MHD generators is presented. Experiments have been conducted in a continuous-electrode MHD generator with externally augmented electric fields to investigate the influence of electrode separation on the development and effects of the ionization instability. A linear perturbation analysis of the governing equations was developed to predict the dependence of the critical Hall parameter for growth of the instability on the electrode separation, current density, and magnetic field. The linear-perturbation analysis was performed on a set of equations describing the free electrons and consisting of Ohm's law, the electron energy equation, the Saha equation, Maxwell's relations ($\nabla \cdot J = 0$ and $\nabla \times E = 0$), and the boundary conditions suitable for continuous electrodes. Essential to the analysis is the retention of the radiation and heat conduction terms of the energy equation. The inclusion of the boundary conditions and the wavelength dependent terms (radiation and conduction) in the energy equation allow the prediction of the critical Hall parameter for various modes of the instability and the prediction of the wavelength having the largest growth rate. The experiments were performed in flowing, atmospheric-pressure argon at 2100°K seeded with 0.1% by mole of potassium. The test sections were constructed from three sizes of 2 cm wide fused quartz in order to have three electrode separations (1, 2, and 4.5 cm). The electrodes, made of tungsten, were 15 to 20 cm in length and sectioned into 6 or 8 pieces to measure the current distribution. The current densities were varied up to 3 A/cm^2 and the magnetic field up to 1.65 T. All important dimensions and flow parameters were held constant with the exception of the distance between the electrodes. Both averaged and time resolved measurements were made of the current distributions, probe voltages, and both sodium resonance and potassium continuum radiation. The experimental results and theory were in general agreement and showed that the wavelength decreased with increasing magnetic field, increasing current density, or decreasing electrode separation. The critical Hall parameter was found to decrease with increasing electrode separation and to vary with the current density. From the experiments it was found that the effective Hall parameter decreased with increasing magnetic field or increasing electrode separation. The effective scalar conductivity showed no appreciable change for the three electrode separations. (Diss. Abstr. Int., B)

Facilities and Equipment

Refer also to abstracts 31168, 31206, and 31578.

30936 (COO-112) COMPILATION OF PUMP DEVELOPMENT WORK FOR REACTOR APPLICATIONS. Woll, R. A. (Chicago Operations Office (AEC), Ill.). 22 Aug 1952. 42p. Dep. NTIS.

Declassified 28 Oct 1971.

Development work accomplished and in progress on pumps for cooling and chemical processing of fuels for various reactors is summarized. Only those applications having requirements not met by pumps already developed for other industries are considered. With a few exceptions, such as those for liquid metals, all pumps discussed are of the rotating impeller type. (C.H.)

30937 (RDT-E-3-6-T(2-72)) HORIZONTAL, ELECTRIC MOTOR-DRIVEN, SINGLE-STAGE CENTRIFUGAL PUMP. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Feb 1972. 20p. RSO.

A standard prescribing requirements for horizontal, electric motor-driven, single stage centrifugal pump for nuclear and associated applications is presented. (J.R.D.)

30938 (RDT-P-4-3-T(4-72)) METAL-SHEATHED, MINERAL-INSULATED ELECTRICAL RESISTANCE HEATER. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Apr 1972. 14p. RSO.

A standard prescribing requirements for metal-sheathed mineral-insulated electrical resistance heater for nuclear and associated applications is presented. (J.R.D.)

30939 (TID-4103(Suppl.1)(Rev.3)) ENGINEERING MATERIALS LIST CUMULATIVE INDEX, 1968–1971. (Technical Information Center (AEC), Oak Ridge, Tenn.). Mar 1972. 50p. TIC Free.

Cumulative subject and corporate author indexes that cover all packages of AEC engineering materials that have been announced in the Engineering Materials List (TID-4100, Suppl. 43 through 66) are given. A title list of packages arranged in CAPE-number sequence is also included. (P.C.H.)

30940 TECHNIQUES FOR NONDESTRUCTIVE EVALUATION OF RADIOACTIVE WASTE CAPSULE END CAP WELDS. Crowe,

J. C. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1-1830. Mater. Eval.; 30: No. 5, 93-8(May 1972).

Solid radioactive waste storage requires a high degree of container integrity. The techniques developed at Battelle–Northwest to nondestructively inspect end cap welds for cesium and strontium waste containers are described. Ultrasonic methods have been defined for locating weld anomalies, and acoustic emission techniques are currently being evaluated as a possible additional method to monitor weld quality. Initial ultrasonic and acoustic emission data taken with prototype equipment exhibit good correlation with destructive analysis of sample capsule welds. The ultrasonic inspection system was designed to incorporate a novel data presentation technique. The ultrasonic scanning and data readout system produce a readable, easy-to-interpret record of the weld inspection. The scanning technique can be adapted to X–Y recorder printout or high-speed CRT mapping methods. Future development areas are suggested which could extend the recording method to present depth-of-flaw or signal amplitude information in other ultrasonic inspection applications. (auth)

30941 RADIOGRAPHIC INTENSIFYING SCREENS. Halmshaw, R. (Royal Armament Research and Development Establishment, Fort Halstead, Eng.). Brit. J. Non-Destruct. Test.; 14: No. 2, 45-7(Mar 1972).

Experiments to determine the optimum thicknesses and materials of metal intensifying screens are described. X-rays from 50 kV to 10 MV, and γ-rays, are considered. Further experiments on Japanese fluorometallic screens are described. (auth)

30942 SYSTEMATICS OF NUMERICAL APPROXIMATION PROCEDURES IN THE STATICS AND DYNAMICS OF DESIGN. Brandes, Klaus (Bundesanstalt fuer Materialpruefung, Berlin). Nucl. Eng. Des.; 18: No. 3, 469-85(1972). (In German). (CONF-710903-31).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

The availability of efficient computers has shifted considerable emphasis on the utilization of discontinuous methods in engineering. On the other hand, the availability of these facilities has also enlarged the applicability of analytical solutions of mechanical problems, especially the coupling of analytical and numerical methods. There are several reasons for not applying in every case only the prominent finite difference or finite element methods. In many cases other methods lead to solutions of sufficient accuracy under relatively small requirements for the size of computers and computer-time. It is worthwhile to classify the manifold methods and techniques to realize the common roots and to show how it is possible to develop further methods. The starting points of a classification are the different ways to describe mathematically a physical situation: differential equations (integro-differential equations) and variational principles. On the basis of these two different formulations it is possible to develop various methods to solve special, but also more general, problems in structural mechanics. The variational problem is the basis of the methods associated with the names of Ritz, Trefftz, and Kantorowitsch, but also the most frequently used numerical method, the finite element method, is based thereupon. The differential equations are the starting point of various methods such as finite differences, dynamic relaxation, and collocation (point matching), least squares, and discrete least squares, applied to boundaries and domains. A special case is the application of linear programming to boundary value problems. In cases where there are restrictions in the values of displacements or forces some difficulties arise, and it is intelligent to apply a Simplex-algorithm. A general method to establish finite differences formulation to a whole range of differential equations is based on collocation. Some other methods (transfer matrices, Fourier transforms) can be included in the systematics. Special methods for solving linear equations are applicable directly to the mechanical models (dynamic relaxation, Monte-Carlo method). Such way of application is very interesting and avoids the necessity to establish and to handle large systems of linear equations in the computer. (auth)

30943 MATHEMATICAL MODELING FOR STRUCTURAL ANALYSIS AND DESIGN. Pister, Karl S. (Univ. of California, Berkeley). Nucl. Eng. Des.; 18: No. 3, 353-75(1972). (CONF-710903-26).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Structural design can be defined as an iterative optimization process involving use of empirical information resulting from operational experience, while at the same time relying on predicted behavior derived from theories used to replace experience. A brief review is given of the mathematical modeling and simulation techniques that appear to be useful in the structural design process, emphasizing the need for a carefully integrated approach to the treatment of sub-system problems. The ingredients of design by mathematical simulation include description of a tentative system configuration; specification of the operating conditions (input); choice of a parametrized structure for input–output relations; choice of state variables and development of an algorithm for predicting the evolution of the system; selection of a criterion function, in terms of state variables, by which performance can be judged; and iterative modification of the system to search for optimum performance. Taking these categories as a point of departure, an examination of possibilities and problems attendant to development of a design methodology is made. Particular attention is given to the underlying inter-relations between categories, use of concepts of control theory and the merging of "design art" with "design science". As an illustrative example, the problem of system identification in the context of material characterization, and its direct relation to numerical solution algorithms of field problems in mathematical physics is discussed. The direct implication of this interconnection is the imperative of viewing "materials characterization" and "structural analysis" as interdependent processes in system design. The concept of control, although familiar in the operation of systems, is perhaps less well understood as a useful concept in the design process. Of fundamental importance are ideas emerging from combinatorial mathematics and dynamic programming, leading to a methodology for selecting a policy for iterative modification of the design to seek optimum performance. Similarly, yet in a different context, the idea of feedback control is useful in studying problems of discretization or zoning in numerical analysis as well as zoning for system identification. These, as well as other aspects of the treatment of design via modeling and simulation are developed and illustrated. (auth)

30944 IMPLEMENTATION OF THE RARE-EARTH MAGNET IN ROTATING MACHINERY. Richter, E. (General Electric Co., Erie, Pa.). pp 991-1005 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The recent development of rare earth permanent magnets requires a revision of the application possibilities of permanent magnets in rotating machinery. Some ideas are given on how to make the best use of their characteristics. The two important areas of application, the stationary magnet structure and rotating magnet structure, are discussed separately. Electrically excited machines are compared to those with permanent magnet excitation of both the conventional magnet and the new magnet types. The results of these considerations are twofold, depending upon whether the magnets are used in stationary magnet structures or in rotating magnet structures. Many of the electromagnetic design concepts, which have been developed for ceramic magnet motors, also apply for the new magnets when they are used in stationary magnets (1) provide more than twice the flux densities at higher coercive forces, (2) will withstand more than twice the demagnetization forces, and (3) show much improved thermal properties. New design concepts will have to be developed for the application of rare earth magnets in rotating field structures. Present design concepts have mainly been worked out for Alnico 5-7 (a material with an extremely high remanence flux density but a very low coercive force) which do not fit the rare earth magnets. One possible design concept is outlined in the paper. The significant difference between an Alnico magnet design and a rare earth magnet design lies in the volume of the magnets. The new magnets allow more rotor volume to be used for the mechanical structure, resulting in a more reliable and stronger rotor construction. (auth)

30945 IMPROVEMENTS TO JOINTS IN TUBING THROUGH WHICH LIQUID METAL FLOWS. Carbonnel, Henri (to Groupement Atomique Alsacienne Atlantique). French Patent 2,070,613. 16 Aug 1971. Filed 10 Dec 1969. (In French).

An improved joint for tubing containing liquid metals is described. It consists essentially of at least one annulus compressed between the flanges of the tube to be joined, the annulus being constructed from a ceramic fibrous material and having a cross section approximately equal to that of the flanges. The system is provided with at least one means of exerting pressure over a circular region of the annulus, and at least one cooling device situated at the periphery of the circular region. An application to liquid metals cooled nuclear reactors is suggested. (France)

30946 IMPROVEMENTS IN OR RELATING TO A RADIATION HEAD. Atovmian, Artashes Ervandovich; Gordon, Vladimir Iosifovich; Davydova, Irina Alexeevna; Litvan, Abram Bentsionovich; Mazanko, Boris Pavlovich. British Patent 1,269,900. 6 Apr 1972. Filed 16 Jul 1970.

Reference is made to radiation heads comprising a radioisotope source and intended for use in radiation therapy, or other fields. Conventional radiation heads have considerable size and weight, reducing their mobility, and are structurally complex. The head described includes a shutter structure that also functions as a diaphragm for attaining an exposure field of required shape and dimensions. This structure is formed of movable members of protective material connected to a drive mechanism for producing simultaneous closing or opening movement of the members so as to obturate the beam or adjust its dimensions. An optical exposure field simulator is provided, adjustment of which, with the radiation beam obturated, simulates the desired irradiation area and limits the opening movement of the movable members to correspond to that irradiated area. The head is compact, and is considerably lower in weight than conventional heads, since it does not contain a diaphragm of heavy protective material; it is convenient in operation, and provides reliable protection from radiation outside the exposure field. The optical exposure field simulator comprises a source of light and two pairs of lightproof plates arranged one below the other for displacement in a manner similar to the movable members. (UK)

30947 PROTOTYPE MECHANICAL ENGINEERING AND ADVANCED TECHNIQUES SECTION OF THE CEN GRENOBLE. Daniault, J.; Gervais, R.; Peccoud, M.; Peuch, M. A. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris); No. 164, 55-90(Nov 1971). (In French).

The department of prototype mechanical engineering and advanced techniques of the Nuclear Research Center of Grenoble is chiefly concerned with the development of special nuclear equipment for different laboratories. The department is particularly specialized in techniques which have not yet been developed by industry: vacuum brazing, electron beam welding, electromagnetic forming, diffusion and inlaying welding, and inductive plasma sputtering. Original prototypes have also been developed: neutron diffractometers, irradiation devices for very low and very high temperature reactors, extreme precision apparatus such as mask alignment equipment. (France)

30948 ENGINEERING AND RESEARCH: CONSTRUCTIONS AT THE CEN SACLAY. Droussent, R.; Dubois, R.; Javellaud, J.; Leger, L. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 164, 41-54(Nov 1971). (In French).

Research centers (particularly the Saclay Nuclear Research Center) encounter engineering problems not generally experienced in industry. Physicists, chemist, and biologists require many prototype constructions demanding special skills. The way in which such problems are tackled by the mechanical construction group of Saclay is described. (France)

Heat Transfer and Fluid Flow

Refer also to abstract 32788.

30949 (ORNL-TM-3718) MASS TRANSFER BETWEEN SMALL BUBBLES AND LIQUIDS IN COCURRENT TURBULENT PIPELINE FLOW. Kress, T. S. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 185p. Dep. NTIS. Thesis. Submitted to Tennessee Univ., Knoxville.

Liquid-phase-controlled mobile-interface mass-transfer coefficients were measured for transfer of dissolved oxygen into small helium bubbles in cocurrent turbulent pipeline flow for five different mixtures of glycerine and water. These coefficients were determined by transient response experiments in which the dissolved oxygen was measured at only one position in a closed recirculating loop and recorded as a function of time. Using an independent photographic determination of the interfacial areas, the mass-transfer coefficients were extracted from these measured transients and determined as functions of pipe Reynolds number, Schmidt number, bubble Sauter-mean diameter, and gravitational orientation of the flow. It was found that above pipe Reynolds numbers for which turbulent inertia forces dominate over gravitational forces, horizontal and vertical flow mass-transfer coefficients were identical and varied according to the regression equation $Sh/Sc^{1/2} = 0.34\ Re^{0.94}\ (d_{vs}/D)^{1.0}$. The observed Reynolds number exponent agreed generally with other literature data for cocurrent pipeline flow but did not agree with expectation based on equivalent power dissipation comparisons with agitated vessel data. Below the Reynolds numbers that marked the equivalence of horizontal and vertical flow coefficients, the horizontal-flow coefficients continued to vary according to the equation until, at low flows, severe stratification of the bubbles made operation impractical. The vertical-flow coefficients at these lower Reynolds numbers underwent a transition to approach constant asymptotes characteristic of the bubbles rising through the quiescent liquid. For small bubbles in the most viscous mixture tested, both horizontal and vertical-flow coefficients underwent this transition. An expression was developed for the relative importance of turbulent inertial forces compared to gravitational forces, F_i/F_g. This ratio served as a good criterion for establishing the pipe Reynolds numbers above which horizontal and vertical-flow mass-transfer coefficients were identical. In addition, it proved to be a useful linear scaling factor for calculating the vertical-flow coefficients in the above mentioned transition region. A seemingly anomalous behavior was observed in data for water (plus about 200 ppM N-butyl alcohol) which exhibited a significantly smaller Reynolds number exponent than did data for the other fluid mixtures. To explain this behavior, a two-regime "turbulence interaction" model was formulated by balancing turbulent inertial forces with drag forces. The relationship of the drag forces to the bubble relative-flow Reynolds number gave rise to the two regimes with the division being at $Re_b = 2$. The resulting bubble mean velocities for each regime were then substituted into Frössling-type equations to determine the mass-transfer behavior. The resulting Reynolds number exponent for one of the regimes ($Re_b \leq 2$) agreed well with the observed data but the predicted exponent for the effect of the ratio of bubble mean diameter to conduit diameter, d_{vs}/D, was less than that observed. The mass-transfer equations resulting from the other regime ($Re_b > 2$) agreed well with data for particles in agitated vessels and also compared favorably with the water data mentioned. For comparison, a second analytical model was developed based on surface renewal concepts and an eddy diffusivity that varied with Reynolds number, Schmidt number, bubble diameter, interfacial condition, and position away from an interface. Using a digital computer, a tentative numerical solution was obtained which treated a dimensionless renewal period, T_*, as a parameter. This renewal period was interpreted as being a measure of the rigidity of the interface, $T_* \to 0$ corresponding to fully mobile and $T_* \to$ approximately 2.7 (in this case) to fully rigid interfaces. (auth)

30950 FORCED CONVECTION HEAT TRANSFER IN A CIRCULAR TUBE WITH NON-UNIFORM HEAT FLUX AROUND THE CIRCUMFERENCE. Rapier, A. C. Int. J. Heat Mass Transfer; 15: No. 3, 403-24(Mar 1972). (TRG-Report-2098; RPC/HT/-P(70)6; RPC/PTK/-P(70)16).

An approximate theoretical solution is derived for the temperature variations around the circumference of a circular tube arising from non-uniform wall heat flux. It is shown to be in good agreement with an existing detailed numerical solution. Published experimental data for a non-uniformly heated tube is used to establish the best value for the effective eddy diffusivity of heat in the fluid. A simple formula for calculating temperature variations around tubes in practical cases is proposed. (auth)

30951 EXPERIMENTAL STUDY OF HEAT TRANSFER BY FOUR-TUBE HEAT GENERATING ASSEMBLIES WITH SMOOTH AND ROUGH SURFACES. Abramidze, Sh. P.; Kiknadze, G. I. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 66: No. 1, 145-8(Apr 1972). (In Russian).

Studies of the effect of two-dimensional artificial roughness on the intensity of heat transfer from four-tube heat generating assemblies (HGA) were carried out in the core of the IRT nuclear reactor to evaluate methods of increasing the power of the reactors. Artificial roughness was produced on the surface of experimental heat generating canals of HGA in the form of rectangular transverse bulges with the height h = 0.2 mm and spacing S = 2.6 mm, i.e., the artificial roughness was characterized by the ratio S/h = 13. The results showed that artificial roughness increases the heat transfer coefficient. (auth)

30952 ACOUSTIC TECHNIQUE FOR THE PROMPT DETECTION OF BOILING IN NUCLEAR POWER REACTORS. Butler, Walter Richard. College Park, Md.; Univ. of Maryland (1971). 65p. University Microfilms Order No. 72-12,831. Thesis.

Efforts to measure the state of boiling in large systems by detecting the sound waves generated directly by boiling have recently been reported, and the difficulties that stem from background noise tending to obscure the very low intensity sound generated by the boiling phenomena have been noted. In this investigation, discrete frequency sound waves were injected into a fueled medium with sufficient intensity to create sound signals that are well above the background noise level. The attenuation of the injected sound signals was found to be a strong function of the boiling parameters in the fueled medium. The change in transmitted sound wave pressure can be correlated with the state of boiling within the fueled core and can then serve as a prompt and direct measure of the state of boiling throughout the core. Experimental studies were conducted to measure the attenuation of applied sound waves through water with varying conditions of boiling at atmospheric pressure. The results indicate that acoustic instruments can be effectively used to measure the status of boiling. In one of the tests, for example, sound wave pressure at the receiver point decreased by about two decades as heat flux approached the onset of nucleate boiling. A second set of experiments was conducted in a subcritical reactor assembly with boiling conditions simulated with air bubbles in the water moderator. The results indicate that the attenuation of sound waves by local regions of simulated boiling is identifiable even in a complex heterogeneous medium of fuel-water mixtures. For example, with the sound source placed four inches and the sound receiver eight inches from the surface of the boiling simulator, the sound wave pressure decreased by a factor of ten when the boiling simulator was turned on. (Diss. Abstr. Int., B)

30953 SURVEY OF RECENT DEVELOPMENTS IN THE FIELDS OF HEAT CONDUCTION IN SOLIDS AND THERMO-ELASTICITY. Boley, B. A. (Cornell Univ., Ithaca, N. Y.). Nucl. Eng. Des.; 18: No. 3, 377-99(1972). (CONF-710903-27).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

The developments of the last few years in both the fields of heat conduction in solids and of thermo-elasticity are reviewed. Attention is centered in both instances on solutions, results, and techniques of direct engineering application with comparatively less emphasis on those of primarily theoretical interest. Thus in the calculation of either the temperature or of the consequent mechanical response both exact and approximate approaches are treated; in the latter case this includes an assessment of the error involved, and in some problems the determination of bounds to the exact solution. A brief review of the basic theory, including the effects of thermo-mechanical coupling and the conditions under which these effects may safely be ignored in practice is presented. Heat conduction is discussed, including a summary of recent solutions for rods, cylinders, and other structural members, and of recent advances in numerical techniques. Extensions of known approximate analytical procedures are indicated, and the conclusions to which they lead are compared with pertinent exact results. The status of heat-conduction calculations involving changes of phase is summarized; results pertaining to plates, cylinders, and spheres are quoted, and analytical short-time solutions and numerical long-time calculations are discussed, and results in two- and three-dimensional melting are presented. Recent thermoelastic results pertaining to rods, beams, plates, cylinders, and spheres are reviewed. The importance of thermally induced vibrations is assessed, and an approximate formula for its evaluation is presented. Bounds for the stresses, deflections, and the torsional rigidity of beams and plates under arbitrary temperature distributions are calculated by means of a simple analogy. The calculation of thermal stresses in indeterminate structures such as rings is critically examined, and the proper use of energy methods in such cases is indicated. New results concerning the mechanical response of melting plates are quoted. Developments concerning thermal-stress calculations in which an extension to visco-elastic materials is readily carried out, are briefly referred to. A comprehensive bibliography of recently published papers in heat conduction and thermoelasticity is included. (auth)

Materials Testing

Refer also to abstracts 31189, 31196, and 31477.

30954 (AAEC/TM-598) COLOUR FILM TECHNIQUES FOR HOT-CELL RADIOGRAPHY. Arthur, J.; Blake, R. G.; Kelly, P. M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aug 1971. 19p. Dep. NTIS (U. S. Sales Only).

Processing and exposure conditions required to produce good color radiographs of dummy fuel pins are described. Using a traveling microscope, cladding tube diameters, fuel pellet diameters, and tube/pellet gaps were measured on color radiographs to an accuracy of better than ±0.002 inches. The minimum detectable tube/pellet gap was 0.003 inches. In all cases the color radiographs proved to be as good as or better than black and white radiographs of the same object. To use a microdensitometer to measure color radiographs, it was necessary to print the radiographs on black and white film. A suitable black and white emulsion for this process was established and the results obtained compare favorably with those taken from black and white radiographs. Color film is more tolerant to gamma radiation than an equivalent black and white x-ray film. (auth)

30955 (CONF-701105-, pp 155-64) HOLOGRAPHIC INTERFEROMETRIC STUDIES OF CARBON COMPOSITE CYLINDERS. Burchett, O. J.; Murphy, C. G.; Matthews, C. W. (Sandia Labs., Albuquerque, N. Mex.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

Initial feasibility studies on carbon composite cylinders indicated that the location of failure corresponded to highly deformed areas which were previously located by holographic interferometry at low stress levels. Calibration studies on aluminum cylinders were then done to ascertain the limitations and experimental errors in the testing procedures. Correspondence was obtained between circumferential strain values obtained by interferometry and by strain gages. Perspective angle and spherical wave corrections were necessary to achieve a high degree of accuracy at the viewed extremes of the cylinders. Emulsion shrinkage was found to distort the images on real-time studies. Anomalous points on the cylinders could be easily found. (auth)

30956 (CONF-701105-, pp 165-96) ULTRASONIC CHARACTERIZATION AND COMPUTERIZED ANALYSIS OF GRAPHITE BILLETS. Baker, R. A.; Bishop, D. E.; Stoker, G. C. (Sandia Labs., Albuquerque, N. Mex.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

A computer aided, ultrasonic test system for graphite billets has been developed, the primary purpose of which is to select the optimum location within the billet of a reentry vehicle nose tip. An on-line mini-computer provides process control functions and initial data processing. Further data processing and billet quality analysis are provided by a large computer. Visualization of the internal structure is aided by the use of a computer-controlled plotter. The ultrasonic test system consists of a commercial ultrasonic tester with an automatic scanning and immersion system. Position readout indicators provide scan position and part rotation information. A special interface module receives ultrasonic test data from the tester and converts this information to analog voltages, while an auxiliary function module, controlled by the mini-computer, digitizes and records the position and ultrasonic information on magnetic tape. The large computer analyzes the ultrasonic flaw data in terms of the up to 3300 possible nose-tip locations within the billet. In evaluating each particular nose-tip location, every flaw indication is assigned a weight. These weights are totaled for that cone location. The 15 positions having the lowest weights are presented to the design engineer for his final selection. The plotter is used to provide graphical pictures of the flaws within the billet to aid the engineer in his selection of the optimum position of the nose tip. Plots are made showing all of the flaws in the billet by subdividing into slabs which run parallel to the billet axis and into discs perpendicular to the axis. Such plots show the flaw distribution in a clear, concise manner. Further programs plot histograms of the data with respect to three location parameters. (auth)

30957 (CONF-720301-5) THICKNESS MEASUREMENTS USING EDDY-CURRENT TECHNIQUES. Dodd, C. V.; Simpson, W. A. Jr. (Oak Ridge National Lab., Tenn.). [1971]. Contract W-7405-eng-26. 17p. Dep. NTIS.

From Spring conference of the American Society for Nondestructive Testing; Los Angeles, Calif. (13 Mar 1972).

Eddy currents have been used for many years to measure the thickness of a single conductor and the thickness of one conductor clad on another. A computer analysis of the problem was used to choose the optimum conditions for performing such measurements. Effects of varying thickness, frequency, coil size, conductivity, lift-off (or coil-to-conductor spacing), and coil resistance are discussed. The use of a phase-sensitive eddy-current instrument in performing thickness and clad thickness measurements is emphasized. (auth)

30958 (CONF-720504-1) SHAPE FACTORS FOR NOZZLE CORNER CRACKS. Derby, R. W. (Oak Ridge National Lab., Tenn.). [1972]. 23p. Dep. NTIS.

From Society for Experimental Stress Analysis meeting; Cleveland, Oh. (19 May 1972).

Results of research directed toward evaluation of cracks in heavy steel pressure vessel nozzles are presented with emphasis on shape factors for these types of cracks. Information and discussions are included on fracture toughness measurements, shape factors, and sample calculations for reactor vessels. (J.R.D.)

30959 APPARATUS FOR PRODUCING RADIOGRAPHS OF CURVED PLANES IN AN OBJECT. Wright, W. E. (to General Electric Co.). Canadian Patent 887,892. 7 Dec 1971.

To obtain a panoramic dental radiograph, an x-ray source and a film cassette are mounted on opposite ends of an arm that swings in a horizontal plane about a vertical axis so that the cassette and source jointly orbit the patient. On an overhead base is a first carriage which is on a track that constrains the carriage to move back and forth in a single line along one coordinate axis. A second carriage is carried on the first carriage and is on a track that constrains it to move only at a right angle to the first carriage along the other coordinate axis. The second carriage has a bearing that supports the horizontal arm. A driving arm is engaged with the second carriage and drives both carriages so that their resultant motion is a semi-ellipse that approximates the shape of the dental arch. The vertical rotational axis of the arm is always on the semi-ellipse or other desired curve. Means are provided for translating the cassette and for keeping the arm perpendicular to the curve at all times. (Canada)

30960 RADIOGRAPHY AND RADIATION DAMAGE OF COMPOSITE SOLID PROPELLANTS. Venkitakrishnan, M. K.; Uttam, M. C.; Kurup, M. R. (ISRO, Thumba, India). pp 43-8 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.2).

γ-Radiography as a method of flaw detection in solid propellants is analyzed. The problem of testing propellants of various dimensions envisaged in space programs is discussed. An evaluation of the absorption co-efficients for various compositions and sources is presented. To get good sharpness and optimum density in the radiograph, different geometries are analyzed for different sections of the grain. Calculation for the maximum dose absorbed in testing propellant blocks is done. Methods are suggested to avoid accumulation of static electricity in the propellant while radiography is in progress. The extent of radiation damage while testing propellants was studied. The changes in physical properties such as tensile strength, elongation, hardness, decomposition, and gas evolution for different doses of absorbed radiation were studied. These data are compared with the values for the pure ingredients. A limit is put to the maximum safe dose in propellant radiography. (auth)

30961 NEW METHOD OF SHORTENING EXPOSURE TIMES IN NEUTRON RADIOGRAPHY. Hunt, C. A. (Royal Armament Research and Development Establishment, Fort Halstead, Eng.). Brit. J. Non-Destruct. Test.; 14: No. 2, 57-8(Mar 1972).

In order to overcome difficulties experienced with non-reactor sources of neutrons (e.g., ^{124}Sb/Be and x-rays/Be) where the large photon beams present render a direct technique for neutron radiography difficult, an indirect technique can be used. However, this technique is lengthy but the experiments described show that the process can be considerably speeded up by placing a phosphor layer between the active foil used and the film during the transfer exposure. (UK)

30962 PRESENT STATE OF NEUTRON RADIOGRAPHY AND ITS POTENTIAL. Berger, Harold (Argonne National Lab., Ill.). Brit. J. Non-Destruct. Test.; 14: No. 2, 34-44(Mar 1972).

The present state of thermal-neutron radiography as it relates to industrial applications is reviewed. Techniques of neutron radiography are well developed. A commercial neutron-radiographic service can be obtained in several countries. Equipments for neutron radiography in nonnuclear organizations are now going into service; the progress of these will indicate the growth of neutron radiography. Some predictions concerning the future of this technique are given. (auth)

30963 TRANSPARENT MATERIALS BY MEANS OF RADIATIONS. DEVELOPMENT OF DEVICES FOR INDUSTRIAL RADIOPHOTOGRAPHY AND THEIR APPLICABILITIES. Crawford, A. H. Elektron.-Ztg.; 9: No. 23-24, 8-9(1971). (In German).

Several aspects of industrial radiography are briefly reviewed and include: selection of radiation sources (electrons, neutrons, x-rays and gamma rays); safety aspects; protective shielding; image formation; and fields of application. (INIS)

30964 EFFECT OF FILLETS ON STRESS CONCENTRATIONS IN CYLINDRICAL SHELLS WITH STEP CHANGES IN OUTSIDE DIAMETER. Gwaltney, R. C.; Corum, J. M.; Greenstreet, W. L. (Oak Ridge National Lab., Tenn.). J. Eng. Ind.; 93: No. 4, 986-92(Nov 1971).

The effect of varying the radii of circumferential fillets in the transition region of cylindrical shells with a step change in outside diameter and loaded with internal pressure has been examined by means of finite element analyses for 27 models. Parameters studied were ratios of the thickness of the thicker section to the thickness of the thinner section, ratios of the fillet radius to thickness of the thinner section, and ratios of the inside radius of the cylindrical shell to the thickness of the thinner section. Comparisons are presented between experimental and theoretical results for two experimental models, and duplicate analyses for two cases were made with different computer programs for comparison purposes. (auth)

30965 USE OF CELLULOSE NITRATE FOR ALPHA AUTORADIOGRAPHY. Kegley, T. M. Jr. (Oak Ridge National Lab., Tenn.). Metallography; 5: No. 2, 113-23(Apr 1972).

Plastic- and specimen-supported cellulose nitrate detector films were employed in the alpha autoradiography of metallographic specimens containing uranium and plutonium. For autoradiographs made with plastic-supported film, the film was removed from the specimen prior to developing in 6 N sodium hydroxide. For autoradiographs made with specimen-supported film, the film was developed directly on the polished surface of the specimen. The specimen-supported detector film was placed on the surface of the specimen. The specimen-supported detector film was placed on the surface of the specimen by one of two methods: (1) dropping a 5.5% solution of pyroxylin (form of cellulose nitrate) in amyl acetate onto the surface, or (2) wetting or fixing onto the surface a film of cellulose nitrate which has been stripped from a glass plate. Finer alpha tracks were obtained by developing the exposed cellulose nitrate in 6 N sodium hydroxide at room temperature rather than at 50 to 60°C. Resolution of the cellulose nitrate detector film was improved by use of a 0.00045-in. aluminum absorber between the specimen and the film. (auth)

30966 STRESS ANALYSIS OF PLATES WITH SINGLE AND CLUSTERED NOZZLES BY THE BOUNDARY POINT LEAST SQUARES METHOD. Hulbert, L. E.; Hopper, A. T.; Rybicki, E. F. (Battelle Memorial Inst., Columbus, Ohio). J. Eng. Ind.; 93: No. 4, 929-34(Nov 1971).

A method for determining the stresses and displacements in structures consisting of a flat plate with one or two nozzles attached normal to the plane of the plate is described. The analysis procedure can be viewed as the solution of three interdependent subproblems: (a) the stress analysis of the nozzle, (b) the plane-stress analysis of the plate membrane problem, and (c) the analysis of the transverse bending deformation in the plate. The solutions of these three problems are interrelated in the total solution through continuity and equilibrium conditions at the nozzle-plate interface. The numerical techniques employed are discussed and typical results obtained are discussed. (auth)

30967 ISOTHERMAL ANALOGY FOR THERMAL STRESS IN SHELLS. Hannon, B. M. (Univ. of Illinois, Urbana). J. Eng. Ind.; 93: No. 4, 913-18(Nov 1971).

The theory for a set of analogous surface loads for an isothermal model is presented for a shell which is subjected to temperature gradients. Model stresses are determined by experiment and translated into prototype stresses. The complete set of model boundary condition equations is presented for orthogonal coordinate boundaries. Examples of a heated plate and cylindrical shell with various boundary conditions demonstrate the theory. (auth)

30968 WHAT MAKES A GOOD WELD: AND RADIOGRAPHY CAN PROVE IT. Buckrop, R. L. (Army Weapons Command, Rock Island, Ill.). Mater. Eval.; 30: No. 5, 25A-31A(May 1972).

The use of radiography in the inspection of welds is described. The subject is discussed under the following topics: weld bead material characteristics; weld fabrication; the radiographic process; making a radiograph; radiographic inspection; radiographic sensitivity; and typical weld joint flaws. It is concluded that radiographic inspection of welds is a valuable tool, however, it must be used with caution, taking into account all of the known technique hazards and limitations so as not to be misled by the apparent simplicity of the method. (R.C.K.)

30969 DESIGN AND METALLURGICAL PROBLEMS ASSOCIATED WITH PRESERVICE AND INSERVICE INSPECTION OF NUCLEAR SYSTEMS. Lautzenheiser, C. E. (Southwest Research Inst., San Antonio, Tex.); Ahlberg, Goran. Mater. Eval.; 30: No. 5, 99-102(May 1972).

Until recently, reactor system design and material choice did not consider the problems of inservice inspection. Material selection is usually made on serviceability requirements, which can cause inservice inspection difficulties. Some of the materials problems and associated reactor designs currently in use and metallurgical problems encountered during preservice and inservice inspection are discussed. (auth)

30970 MODULATION TRANSFER FUNCTION AND EFFECTIVE FOCAL SPOT AS RELATED TO NEUTRON RADIOGRAPHY. Bossi, R. H.; Cason, J. L.; Jackson, C. N. Jr. (Westinghouse Hanford Co., Richland, Wash.). Contract AT(45-1)-2170. Mater. Eval.; 30: No. 5, 103-8; 112(May 1972).

The modulation transfer function (MTF) has been proposed for use in describing image quality capability in neutron radiography. The results of an initial experiment provide a quantitative measure of the neutron source's beam resolution characteristics as related to image formation. The effective focal spot of a neutron source has also been defined in conjunction with the MTF analysis in order to establish a basis for comparing neutron sources, as well as characterizing unsharpness and radiographic sensitivity. The effective focal spot, similar to the x-ray focal spot in use, is not necessarily a collimator input diameter, but rather represents the effective ability of a collimator to provide a directed beam of neutrons, taking into account neutron scatter and penumbra effects. For this investigation, the neutron source was the Plutonium Recycle Critical Facility (PRCF). A comparison of the PRCF with other neutron sources for radiography may be made by use of the MTF. The effective focal spot was found to be about 3.1 in. (auth)

30971 DETECTION OF ACOUSTIC EMISSION IN STRUCTURAL ELEMENTS. Miloserdin, Yu. V.; Baranov, V. M.; Molodtsov, K. I. At. Energ. (USSR); 32: No. 4, 330-1(Apr 1972). (In Russian).

Sonic and ultrasonic generation during the deformation of materials (acoustic emission) may be employed in the defectoscopic investigation of reactor elements. Acoustic warning signals are produced when cracks arise in structural members. The detecting apparatus may consist of a pulse detector, and either an oscillograph or other recorder. More elaborate equipment for registering microcracks is described in block diagram form, and includes an acoustic transducer, piezoelectric gage, preamplifier, amplifier, and recorder. (K.S.W.)

30972 CORRECTING FOR NONLINEAR EFFECTS IN FRACTURE TOUGHNESS TESTING. Liebowitz, H.; Eftis, J. (George Washington Univ., Washington, D. C.). Nucl. Eng. Des.; 18: No. 3, 457-67(1972). (CONF-710903-30).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Expressions for fracture toughness, which include nonlinear effects due to crack front plastic yield and possible small crack extension prior to fracture instability, are obtained for several test specimen configurations. Inclusion of such effects is based on a simple compliance type determination of the total energy rate at onset of fast fracture. (auth)

30973 THERMAL-NEUTRON RADIOGRAPHY WITH A SEALED-TUBE NEUTRON GENERATOR AND WATER MODERATOR. Vasilik, Dennis G. (Dow Chemical Co., Golden, Colo.); Murri, Richard L.; Fisher, George P. Nucl. Technol.; 14: No. 3, 279-83(Jun 1972).

Neutron radiography studies were conducted using an accelerator source of 14.3 ± 0.3 MeV neutrons and a water moderator. The yield of the accelerator was 6.18×10^{10} n/sec. The peak thermal neutron flux of the system was measured to be 6.87×10^7 n/cm^2-sec at 5.1 cm from the source. A cadmium ratio of 3.4 was measured at this position. A theoretical two-group analysis of the thermal neutron flux distribution was also performed. The experimental data verified the theoretical results. Neutron multiplication experiments were also conducted by bombarding a ^{238}U target surrounded by the water moderator. It was experimentally determined that 2.5 cm of ^{238}U yielded a maximum multiplication factor of 2.5. (auth)

30974 EDDY CURRENT DIAMETRAL EXTENSOMETER FOR TESTING PRESSURIZED TUBULAR SPECIMENS. Yancey, M. E. (Idaho Nuclear Corp., Idaho Falls); Meyers, C. L. Jr. J. Mater.; 7: No. 1, 14-17(Mar 1972).

A diametrical extensometer was developed which provides a method of continuously monitoring long-term creep in the diameter of tubular specimens. The specimens were pressurized in temperature environments ranging as high as 1300°F. With this system it is possible to scan the changes in four specimens at three different locations along each specimen's length. Results from an experimental application point out the usefulness of the extensometer. (auth)

30975 SCREEN FOR FAST NEUTRON NEUTRONOGRAPHY. Berthod, Jacques (to Commissariat a l'Energie Atomique). French Patent 2,074,567. 8 Oct 1971. Filed 5 Jan 1970. (In French).

A thin screen has been developed for neutronography. It has a homogeneous composition and consists principally of two substances: the first substance (hydrogenated material) has a high neutron capture cross section and emits protons as a result of being bombarded with neutrons; the second substance (ZnS) is luminescent. The thickness of the screen is of the same order as the path of the protons in the screen. (France)

30976 IN-SERVICE NONDESTRUCTIVE INSPECTION OF NUCLEAR REACTOR VESSEL. Amano, M.; Ishikawa, K. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Genshiryoku Kogyo; 17: No. 11, 44-8; 95(Nov 1971). (In Japanese).

The ASME code was established for pressure boundary equipment for reactor coolants; reactor pressure vessels being the main part. In the ASME code, the equipment to which in-service inspection is to be applied are all of pressure vessels, piping, valves, pumps, and pipe supports. The inspection has been started in the US, Sweden, and West Germany. The No. 2 and No. 3 reactors in the Fukushima nuclear power plant are going to be first large-scale example of such inspection in Japan. One of the problems in this inspection is that it is performed in the presence of high radiation levels. Design of the equipment so as to make the inspection possible and the development of automatic remotely operated supersonic flaw detection techniques have made this inspection possible. One of the methods recently being actively investigated is acoustic emission. This seems to be the dominant in-service inspection method of the future because of its unique advantages. (Japan)

Nuclear Explosions

Refer also to abstracts 31046, 31169, 31184, 31185, and 32945.

30977 (NVO-112) PROJECT RULISON FINAL OPERATIONAL RADIOACTIVITY REPORT [ON THE] PRODUCTION TESTS. Gotchy, R. L. (Nevada Operations Office, Las Vegas. Peaceful Applications Div.). Feb 1972. 74p. (PNE-R-57). Dep. NTIS.

A summary is presented of most of the significant radiological surveillance data generated during the production tests of Project Rulison, a nuclear gas stimulation experiment, detonated September 10, 1969, in Northwestern Colorado. It also includes data on the radiochemical and chemical quality of the Rulison gas during the tests and estimates of the quantities of ^{3}H, ^{85}Kr, ^{14}C, and ^{203}Hg released to the atmosphere as a result of the tests. (auth)

30978 (UCRL-73427) DIAGNOSTIC PROBLEMS RELATED TO MEASUREMENTS NEAR UNDERGOUND NUCLEAR DETONATIONS. Olsen, Clifford W. (California Univ., Livermore. Lawrence Livermore Lab.). 23 Feb 1972. 23p. (CONF-720417-1). Dep. NTIS.

From seventh transducer workshop; Albuquerque, NM. (4 Apr 1972).

Problems associated with measuring data related to containment of underground nuclear detonations are very difficult to overcome, particularly with a line-of-sight pipe from the detonation. Measurements of pressure, temperature, radiation, acceleration, particle velocity, and shock position are routinely fielded. Measurements of other variables, such as gas density and optical transparency or brightness have been attempted. One must have a system that can survive high radiation levels, high shock loading, large electromagnetic noise pulses, and blast conditions; a system with frequency response in the 50 to 100 kHz region, while having from 1500 to 4000 ft of cable between the transducer and the electronic recording equipment, is also required. The reliability and dynamic range of the system must be large, since channel limitations do not often permit much redundancy. Contributing to the problem is the poor predictive capability for many of the variables, particularly along a line-of-sight. Dynamic calibration of pressure and temperature sensors is necessary for understanding the data, and a particular problem is the inability to measure stagnation properties and flow velocities behind the first arrival.The current practices at LLL with regard to transducers and cables are discussed, along with the shortcomings of the present capability. (auth)

30979 (USGS-474-121) WATER-WELL INVESTIGATIONS BEFORE AND AFTER THE STERLING EVENT IN TATUM SALT DOME, LAMAR COUNTY, MISSISSIPPI. Taylor, R. E.; Oakley, W. T. (Geological Survey, Denver, Colo.). 1968. Contract AT(29-2)-474. 10p. Dep. NTIS.

Prior to the Sterling Event in Tatum salt dome, water wells within a 5-mile radius of ground zero were reinventoried. Data collection was expedited by use of a simplified data form developed specifically for reinventory purposes. Forty-six new or revised wells were added to the previous well inventory. Investigation of eight well-damage complaints after the event showed natural conditions, rather than the nuclear detonation, caused the damage. (auth)

Detection Systems

Refer also to abstracts 30742, 30743, 31182, and 31183.

30980 (FOA-4-4464) SEISMOMETRIC ESTIMATES OF UNDERGROUND NUCLEAR EXPLOSION YIELDS. Ericsson, Ulf (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Jun 1971. 87p. Dep. NTIS (U. S. Sales Only).

A linear and stochastic model of the connection between seismic surface and body wave magnitudes and the energy yield of underground nuclear explosions is adapted to the maximum likelihood estimation of yields from magnitudes measured in seismograph station networks. Standard deviations and confidence ranges are also obtained. Application to the calibrated situation of explosions in the yield range from 70 to 1200 kt in the Pahute Mesa at the Nevada Test Site and magnitudes from Canadian stations shows that the precision of such estimates, as measured by the standard deviation of the logarithm of the yield, ranges from 0.3 with one average body wave station to 0.03 when 19 body wave stations and 19 surface wave stations are used, the latter precision being well comparable with radiochemical yield determinations. The yield estimate from one average surface wave station is as precise as the joint estimate from four average body wave stations. Applications to a few explosions with known yields outside the Pahute Mesa but at the Nevada Test Site and also in New Mexico and Colorado had an average log-yield accuracy of roughly ±0.2. For explosions under Amchitka Island the model was numerically unsuitable. The ratio of yields estimated from surface and body waves is employed as a yield independent indicator of departure from the conditions at the reference sources in Pahute Mesa. The surface wave yields from explosions under Yucca Flat at Nevada Test Site are systematically only half of the body wave yields. The possibility of such source area biases reduces the yields seismometrically estimated for other source areas than Pahute Mesa, to equivalent yields. Such yields are affected by the explosion depth and by the explosions medium. Several formulas of secondary or tertiary reliability are obtained for the seismometric estimation of the yields of US and USSR explosions when only some of the current single station or average network magnitudes are available, including provisional formulas for the Hagfors Observatory. Accuracy and precision are estimated. Applications are made to some of the US and USSR explosions, for which the official yields have not been published. (auth) (Sweden)

30981 (FOA-4-4480) EVENT IDENTIFICATION BY m(M) OBSERVATIONS FROM NETWORKS. Ericsson, Ulf (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Nov 1971. 110p. Dep. NTIS (U. S. Sales Only).

Discriminants in the form of statistically optimal linear combinations of the surface and body wave magnitudes from four seismometric networks are designed so as to be independent of the explosion yields. They are also found to be independent of the equivalent yields of the earthquakes studied. The yields or equivalent yields of the events range from several thousand megatons down to five kilotons. The effectiveness of the discriminants is described by identification curves, the equivalent of the receiver operation characteristics employed in the analysis of telecommunications and by confidence limits developed for the purpose. At the probability of one false alarm in one thousand earthquakes, with the 99% confidence available probabilities for correct identification of explosions are found to range widely between source areas and between monitoring networks. Probabilities of more than 90% for the correct identification of explosions are found when explosions in eastern Kazachstan and earthquakes in some source areas in Asia are monitored by a certain worldwide network of eight stations in Scotland, Canada, India, Australia, Pakistan and Iran, whereas only much less than 10% is attainable when a network of nineteen stations in Canada monitors explosions and earthquakes in certain of the source areas in the western US and Mexico. For other source areas in the same parts of North America and Asia these networks obtain intermediate results. Under the mentioned conditions on confidence and false alarms about earthquakes, discrimination by the network in Canada does not reach above 12% correct identification of explosions in North America, whereas a station in Sweden obtained 78% for such explosions. Discrimination by the network in Canada is found to be quite sensitive to the choice between adjacent source areas, but the extended earthquake source areas in Kamchatka, the Kuriles and the Aleutians do not display significant inhomogeneities, according to the present data from the mentioned worldwide network or from the large array in Montana. (auth) (Sweden)

30982 (UCRL-73579) PASSIVE NEUTRON PULSE WIDTH TECHNIQUE. Parker, Robert (California Univ., Livermore. Lawrence Livermore Lab.). 22 Feb 1972. 6p. (CONF-720312-5). Dep. NTIS.

From Underground nuclear test measurement symposium II; Menlo Park, Ca. (21 Mar 1972).

The passive pulse-measuring method described exploits the fact that the induced maximum stress in a bar or strip of fissile material rapidly heated by a neutron radiation pulse is in part dependent on the ratio of the heating time to the mechanical response of the bar. The mechanical response of a bar is proportional to the length of the bar. Permanent deformation induced in an array of carefully measured bars of varying lengths may be determined after radiation exposure. Since the temperature rise the bars experienced is known (using radiochemistry), postshot calibration and calculations will determine "characteristic" heating times and radiation pulse widths. (2 figures) (auth)

30983 MULTISITE ESTIMATION OF EXPLOSIVE SOURCE PARAMETERS. Filson, John; Frasier, Clint W. (Massachusetts Inst. of Tech., Lexington). J. Geophys. Res.; 77: No. 11, 2045-61 (10 Apr 1972).

Short-period P waves from five presumed explosions in eastern Kazakh with magnitudes m_b ranging from 5.3 to 5.7 were examined at five teleseismic arrays: Lasa, YKA, OONW, WRA, and GBA. Time domain transfer functions that convert the lower-magnitude events to the largest event at the individual sensors of each array were calculated. These filters show that the observed source radiation of each event is space stationary over the aperture of each array but varies from array to array. At the Large-Aperture Seismic Array (Lasa) these transfer functions qualitatively match theoretical transfer functions based on Blake's solution for the seismic radiation from a cavity excited by a step function in pressure, in which the cavity radius for each event is scaled according to the Lasa magnitude. When all the arrays are considered simultaneously, apparent anisotropic radiation is seen in two of the five events, where an amplitude variation up to a factor of 3 is observed between two array sites. Multisite estimation of the source parameters is attempted in the frequency domain, in which Haskell's explosion spectral model is fitted to each event spectrum after corrections for instrument response and attenuation are applied. At each array the attenuation that allows the fitted parameters to vary as dictated by the model is chosen as correct. With attenuation estimated at each array, the spectra observed at all arrays for a single event are simultaneously fitted to the three parameters of Haskell's source model. For most arrays the individual and simultaneous fitting schemes yield reasonable values for the source parameters. The assumed source model and the estimated attenuation parameter for central Asia to Lasa apparently explain why the spectral ratio of high- to low-frequency energy in explosion sources increases as yield decreases. (auth)

Civil Uses

30984 (UCID-15922) PREDICTION OF SPALL PHENOMENA AND NEAR SURFACE EFFECTS FOR PROJECT RIO BLANCO. Terhune, R. W. (California Univ., Livermore. Lawrence Radiation Lab.). 18 Oct 1971. Contract W-7405-eng-48. 20p. (PNE-RB-14). Dep. NTIS.

Project Rio Blanco is a proposed multiple nuclear explosive gas stimulation experiment. The gas sands to be stimulated are overlain by a rich oil shale section. A computer study to determine if the oil shale will be fractured by the Rio Blanco experiment is presented. The calculations used the material properties measured for the Green River oil shale, logging data from two nearby wells, and also material properties developed for Wagon Wheel shale. The calculations predicted that compressive fracture would not extend beyond 5 cavity radii (350 ft) from the detonation point and that tensile fracture is confined to within 170 ft of the free surface. The peak spall velocity at the surface directly above the detonation point was predicted to be 2.5 m/sec. A series of calculations, using zero tensile strength and the failure surface for a highly fractured shale were made in which layers of various impedance mismatch were examined. Fracture or separation on previous existing fractures was not predicted even though a sharp discontinuous impedance mismatch up to twice those observed was examined. (auth)

30985 (UCRL-51181) SCHOONER SURFACE MOTION AND VENTED-GAS TEMPERATURE MEASUREMENTS. Rohrer, Robert F. (California Univ., Livermore. Lawrence Livermore Lab.). 14 Feb 1972. Contract W-7405-eng-48. 27p. Dep. NTIS.

Surface motion data as a function of time are presented for the Schooner nuclear cratering event. Data for the surface-motion time history up to the time of vent were obtained through the use of surface flares, high-speed photography, and film analysis with a digital computer. Graphs are presented showing vertical displacement and vertical velocity of individual surface motion target flares versus time. Comparison of selected peak spall velocities obtained from the flares is made with selected peak spall velocities obtained from nearby accelerometers. The peak spall velocity determined by the flare experiment was 55 m/s, while that from the accelerometer was 67 m/s. Also discussed are vented-gas temperatures as a function of time, determined by measurement of the density of the photographic images of the gas cloud on motion picture film. The hottest temperature recorded was 2590°C at ~2.1 s after detonation time, or ~0.36 s after the first vent. (auth)

30986 CONSIDERATION OF THE RADIOLOGICAL IMPACT FROM THE HYPOTHETICAL USE OF CONTAMINATED NATURAL GAS FROM NUCLEARLY STIMULATED RESERVOIRS. Jacobs, D. G.; Struxness, E. G. (Oak Ridge National Lab., Tenn.). Health Phys.; 22: No. 5, 429-40(May 1972).

The hazards from commercial application of nuclear explosives in the natural gas industry are considered with particular reference to Project Gasbuggy (1967) and the El Paso, Texas, Natural Gas Company's Blanco and Ignacio gas processing plants, which use gas from the collection system in the San Juan Basin. The concentrations of tritium and ^{85}Kr at the beginning of production testing were about 700 and 110 pCi/cm^3, respectively, and the concentration decreased exponentially with the quantity of gas removed from the well. Traces of ^{37}Ar and ^{39}Ar, fission product rare gases, and low concentrations of ^{14}C(5700 y half-life) were the only other radionuclides reported to be present in the gas. None of the gas removed from the well actually entered the production system, but an assessment was made of the radiation doses to consumers and workers by considering the hypothetical introduction of Gasbuggy gas into the actual gas collection and processing system during production testing. Workers at the Blanco gas processing plant could potentially receive a dose-equivalent to the gonads of 0.3 mrem during the processing of Gasbuggy gas and could receive as much as 1.3 mrems if gas processed through the plant were used for home heating with nonvented heaters. Both estimates were for dose received during the lifetime of the well although most of this dose would be received during the first year of gas production. The potential contribution of tritium and ^{85}Kr to the general (atmospheric) background was also considered in areas consuming large quantities of gas, but this was small relative to the potential dose to the individual occupying a space heated home where the combustion products are not vented properly. (UK)

Protective Structures and Equipment

30987 INVESTIGATIONS ON THE PREPARATION AND TESTING OF SOME INORGANIC IODINE FILTER MATERIALS. Donner, Ch.; Tamberg, T. (Hahn-Meitner Institut fuer Kernforschung, Berlin). Kerntechnik; 14: No. 1, 22-8(Jan 1972). In German and English).

Removal efficiencies for methyl iodide were measured for a group of inorganic filter materials pretreated in various ways. Only the Linde molecular sieve of the X-type, exhaustively loaded with silver ions, proved to be a material with a high removal efficiency. The reasons for the unequal removal efficiencies of the materials tested are discussed and cost comparisons between Ag–X–LMS and KI-impregnated activated charcoal filters are presented. (auth)

Safety Engineering

30988 (HMI-B-119) INVESTIGATIONS ABOUT THE ADSORPTION OF GASEOUS FISSION PRODUCTS BY LINDE-MOLECULAR-SIEVES. Donner, Ch.; Schneider, J.; Tamberg, T. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Feb 1972. 58p. (In German). (BC-59). Dep. NTIS (U. S. Sales Only).

Molecular sieves, Filtrolite, Vermiculite, Glauconite, and a sintered glass were used to measure removal efficiencies for CH$_3$I. Only X-type LMS exhaustively loaded with Ag$^+$ ions proved to be a material with high removal efficiency. 44% of the Ag$^+$ ions take part in the removal reaction leading to CH$_3$–O–CH$_3$, CH$_3$OH, and AgI. Rare gas fixation experiments resulted in partial success: A substantial delay in the release of adsorbed Kr from Ag–LMS–X was observed after CH$_3$I treatment. (auth)

Vacuum Engineering

Refer also to abstract 31532.

30989 SIMPLE ULTRAHIGH VACUUM ROTATABLE SEAL. Mills, J. C. (CSIRO, Clayton, Australia). Rev. Sci. Instrum.; 43: No. 5, 819-20(May 1972).

A simple and robust high torque, high vacuum rotatable seal is described. The seal has been tested to a pressure of 4 × 10^{-10} torr and can be adapted to bakable systems. A number of configurations are described. (auth)

30990 ROBUST HIGH VACUUM MULTIPIN ELECTRICAL LEADTHROUGH. Mills, J. C. (CSIRO, Clayton, Australia). Rev. Sci. Instrum.; 43: No. 5, 820-1(May 1972).

A simple multipin leadthrough is described. The seal has been tested to a pressure of 4 × 10^{-10} torr. (auth)

ENVIRONMENTAL AND EARTH SCIENCES

30991 (CONF-711210) PROCEEDINGS OF THE SYMPOSIUM ON AIR POLLUTION, TURBULENCE, AND DIFFUSION [HELD IN LAS CRUCES, NEW MEXICO], DECEMBER 7–10, 1971. Church, H. W.; Luna, R. E. (eds.) (Sandia Labs., Albuquerque, N. Mex.). Mar 1972. 398p. Dep. NTIS.

Forty-nine papers presented in sessions on air resources management, instrumentation and remote sensing, theory of turbulence and boundary layers, climatic effects, and diffusion prediction are included. (J.R.D.)

30992 (RLO-2225-T-25-4) WIND EFFECTS ON CURRENTS OBSERVED IN JUAN DE FUCA SUBMARINE CANYON. Cannon, Glenn A. (Washington Univ., Seattle. Dept. of Oceanography). Jan 1972. Contract AT(45-1)-1725. 18p. Dep. NTIS.

Juan de Fuca submarine canyon has depths exceeding 200 m extending completely across the continental shelf. Observations of currents in the canyon during the winter of 1970 showed relatively large currents and large excursions both in- and out-canyon. Three major flow reversals appear related to major wind reversals as a compensating current to an Ekman surface regime. A fourth wind reversal, not accompanied by flow reversal, indicates that along-canyon density gradients also are important. (auth)

30993 (TID-25979) ATMOSPHERIC TRANSPORT AND DIFFUSION IN THE PLANETARY BOUNDARY LAYER, JULY 1970–JUNE 1971. Van der Hoven, I. (ed.) (National Oceanic and Atmospheric Administration, Silver Spring, Md. Air Resources Labs.). Sep 1971. 87p. Dep. NTIS.

Results of studies of atmospheric transport and diffusion in the planetary boundary layer, micrometeorology, and diffusion climatology are presented. Information is included on three-dimensional trajectories in the Los Angeles Basin, planetary boundary layer dynamics, energy profiles of wind fluctuations, wake turbulence and diffusion, mesoscale transport and dispersion, and automated processing and graphics for the large data base 1969 Los Angeles study. (J.R.D.)

Minerals and Ores

Refer also to abstracts 31025 and 31130.

30994 (GJO-912-1) MINERALOGY AND PARAGENESIS OF THE SCHWARTZWALDER MINE URANIUM ORE, JEFFERSON COUNTY, COLORADO. Heyse, John V. (Pitkin (Lucius) Inc., Grand Junction, Colo. Western Uranium Project). 7 Jul 1971. Contract AT(05-1)-912. 91p. Dep. NTIS.

The mineralogy and petrology of the Schwartzwalder Mine ore is described, with emphasis on determination of paragenetic relationships between individual minerals, groups of minerals, and entire rock units. Also, several factors discussed in previous studies were re-evaluated in light of a fresh approach to the vein mineral paragenesis, increased development of the mine, and extensive x-ray diffraction, sulfur isotope, and linear regression analysis. These factors include: the age of ore deposition; the form and source of the deposit; effects of the host rocks on ore deposition; geochemical mechanism for ore deposition; the type and extent of wall rock alteration; number of brecciation periods; the identity of the primary molybdenum mineral; the existence of a black pyrite; and the relation of radiometric to chemical U_3O_8 values. (P.C.H.)

30995 (GJO-935-1(Pt.1), pp 3-44) LOW ALTITUDE GAMMA-SPECTROMETRIC SURVEYS FROM HELICOPTERS IN PUERTO RICO AS AN EXAMPLE OF THE REMOTE SENSING OF THORIUM, URANIUM, AND POTASSIUM IN SOILS AND ROCKS. Schwarzer, Theresa Flynn; Cook, Beverly Gatlin; Adams, John A. S. (Rice Univ., Houston, Tex. Dept. of Geology). Jun 1971.

In Nuclear techniques in geology and geochemistry.

During 22.7 hours of flying on 5 consecutive days, 8×10^4 data points were recorded along 835 line miles of flight. A pair of 5″ × 5″ NaI(Tl) detectors flown as low as 50 ft yielded reproducible and often highly characteristic thorium, uranium, and potassium "signatures" for the major lithologies and soil types of the 30 by 90 mile island. Formational contacts and zones only a few yards wide could be distinguished in many cases. During the 275 mile survey of the entire beach and coastline, the provenance of several drainage basins was found to be relatable to the absolute and relative concentrations of thorium, uranium, and potassium in the associated beach. The prototype gamma spectrometric system used can provide thorium, uranium, and potassium concentration estimates of considerable value in the preliminary or detailed remote sensing of the earth's surface for many purposes, including soil mapping, geologic mapping, mineral exploration, and environmental radioactivity monitoring. (auth)

30996 (GJO-935-1(Pt.1), pp 45-60) PROGRESS IN THE CALIBRATION OF AIRBORNE GAMMA SPECTROMETERS FOR GEOCHEMICAL EXPLORATION. Cook, B.; Duval, J.; Adams, J. A. S. (Rice Univ., Houston, Tex. Dept. of Geology). Jun 1971.

In Nuclear techniques in geology and geochemistry.

In principle gamma-ray spectrometry can yield quantitative data on the contributions of Th, K, and, in favorable cases, U. In the laboratory the technique has been refined, particularly for Th and K, and less satisfactorily for U because of secular radioactive disequilibria in the ^{238}U series in many geologic samples. After 30 y experience, most logging tools are still giving relative outputs in counts per unit time. Collimated gamma spectrometers for quantitative outcrop measurements have been in use for over 8 y. The calibration of airborne gamma spectrometers is difficult because of the large and usually heterogeneous area surveyed, terrain roughness, and ^{238}U series disequilibria. Altitude and ground speed variations also present problems. Using an outcrop gamma spectrometer to establish ground truth, a helicopter-borne gamma spectrometer operated at an altitude of 50 feet and a ground speed of 60 knots is being calibrated for Th, the simplest case. K is the next simplest case and U will be the most difficult. Quantitative Th/K ratios are particularly convenient outputs. The low-flying helicopter data are considered a necessary intermediate to calibrating fixed-wing systems that survey much larger areas during each measurement interval. (auth)

30997 (GJO-935-1(Pt.1), pp 61-73) EXPERIMENTAL COMPARISON OF NaI(Tl) AND SOLID ORGANIC SCINTILLATION DETECTORS FOR USE IN REMOTE SENSING OF TERRESTRIAL GAMMA RAYS. Adams, J. A. S.; Cook, B. G.; Duval, J. S. Jr.; Fryer, G. E.; Schwarzer, T. F. (Rice Univ., Houston, Tex. Dept. of Geology). Jun 1971.

In Nuclear techniques in geology and geochemistry.

An experimental comparison of NaI(Tl) and solid organic scintillation detectors for the remote sensing of terrestrial gamma radiation is presented. The results show that the organic detectors can be used for this purpose and offer the advantages of being less expensive and more rugged. (auth)

30998 (GJO-935-1(Pt.2)) [NUCLEAR TECHNIQUES IN GEOLOGY AND GEOCHEMISTRY.] Final Report. (Rice Univ., Houston, Tex. Dept. of Geology). Jun 1971. Contract AT(05-1)-935. 158p. Dep. NTIS.

Three sections on experimental investigations of radioactive materials in geologic deposits and in ground and surface waters are presented. A separate abstract was prepared for each section. (L.C.L.)

For abstracts of individual sections see: 30999, 31018, and 31027.

30999 (GJO-935-1(Pt.2), pp 289-302) STUDIES ON THE SWEETWATER GRANITE, WYOMING. Jun 1971.

In Nuclear techniques in geology and geochemistry.

Results are presented from 279 field measurements made on a Mark II collimated gamma-spectrometer to determine the K, Th, and U contents of Sweetwater granite from Wyoming. The significance of the data is discussed. The mean value of K was 3.8%. The average Th content was 25 ± 2 ppM. The average U content was 4.8 ± 0.4 ppM. (L.C.L.)

31000 GEOCHEMISTRY OF RADIOACTIVE (U, Th), ALKALINE (Li, Rb, Cs) ELEMENTS AND BORON IN INTRUSIVE COMPLEXES OF THE CENTRAL KAMCHATKA. Leonova, L. L.; Udal'tsova, N. I.; Volynets, O. N.; Koloskov, A. V.; Flerov, G. B. (Inst. of Volcanology, Petropavlosk, USSR). Geol. Geofiz.; No. 1, 10-16(1971). (In Russian).

Data are presented on the distribution of U, Th, Li, Rb, Cs, and B in rocks of four intrusion complexes: gabbro-syenite, gabbro-plagiogranite, gabbro-granodiorite, and granodiorite-porphyry. From 11 to 18 samples from each complex were analyzed, representing rocks at all phases of intrusion including veins. Flame photometry was used to determine K, Li, Rb, and Cs, and a spectral quantitative method for boron. The analysis of U and Th were conducted by means of luminescence and colorimetry (with arsenazo III). The averaged data on elemental content are tabulated. (tr-auth)

31001 EKSPERIMENTAL'NOE ISSLEDOVANIE MINERALO-OBRAZOVANIYA. (Experimental Investigation of Mineral Formation). Nasedkin, V. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). 436p.

A separate abstract was prepared for each of two chapters selected for inclusion in NSA. (J.R.D.)

For abstracts of individual chapters see: 31405 and 31406.

31002 DISEQUILIBRIUM STUDIES IN ^{232}Th/^{228}Th ACTIVITY RATIO IN SOME SEDIMENT SAMPLES OF INDIA. Joshi, L. U.; Ganguly, A. K. (Bhabha Atomic Research Centre, Trombay, India). pp 137-48 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.2).

A geochemical study of sediment samples is being carried out by EDTA leaching at pH 3.0 in order to investigate the surface phenomena and distribution of natural thorium in backwater sediments. Unusually high values of ^{232}Th/^{228}Th activity ratios have been found in the deposits of the sediments in the Indian coastal region of Bombay and Kerala Belt. The ratio was approximately 1.75 in the Bombay Harbor region and 1.5 at the coastal region of Kerala. The variations in the ratio of ^{232}Th/^{238}Th is most likely due to leaching of ^{228}Ra by seawater resulting in depletion of ^{228}Th in the ^{232}Th decay chain. (auth)

31003 U/He AGES AS INDICATORS OF EXCESS ARGON IN DEEP SEA BASALTS. Fisher, David E. (Univ. of Miami, Fla.). Earth Planet. Sci. Lett.; 14: No. 2, 255-8(Mar 1972).

U/He ages of deep sea basalts which show unequivocal evidence of excess Ar are generally higher than the corresponding K/Ar ages, suggesting that this result is diagnostic of the presence of excess rare gases. Concordant U/He and K/Ar ages are indicative of the validity of such ages. U/He ages lower than the corresponding K/Ar ages are not informative. (auth)

31004 RARE EARTH CONTENTS IN CARBONATITES. Loubet, Michel; Bernat, Michel; Javoy, Marc; Allegre, Claude J. (Univ., Paris). Earth Planet. Sci. Lett.; 14: No. 2, 226-32(Mar 1972).

Mass spectrometric measurements of rare-earth elements were made by isotope dilution in several carbonatites. The results show a great enrichment of total rare earth content and a large fractionation between heavy and light rare earths. The patterns observed permit an easy distinction between limestones and carbonatites. This result suggests that in the carbonatite process the gas phase might play an important role. (auth)

Radioactive Effluents

Refer also to abstracts 30917, 32866, 32872, 32882, and 32897.

31005 OCEANOGRAPHY RESEARCH: SOME NEW PHYSICAL, CHEMICAL, AND RADIOLOGICAL STUDIES IN OCEANOGRAPHY. Walden, H.; Weichart, G.; Kautsky, H. (Deutsches Hydrographisches Institut, Hamburg). Naturwissenschaften; 59: No. 1, 12-22(Jan 1972). (In German).

Some special German investigations of physical, chemical and radiological aspects of oceanography are described. The physical contributions deal with a cruise of the Meteor research vessel in the Icelandic region, the upwelling phenomenon, the relationship between large-scale meteorological and oceanographic processes, and ocean-wave research. As regards marine chemistry, information is given on new developments in instruments which perform continuous and automatic analyses with some practical applications. The radiological contribution concerns the oceanographic problems connected with the disposal of packaged low-level radioactive wastes. (auth)

31006 EXPANSION OF THE POWER GENERATION SYSTEM. Kroms, Anton. Elektrizitaetswirtschaft; 70: No. 20, 591-600 (1971). (In German).

The power generation system is influenced by an unprecedented increase of power demand. The demand has reached such proportions that not only are the availability and costs of the primary energy carriers of importance, but also the requirements for protection of the environment are important. Most power plants use fossil fuels such as coal, oil, and natural gas as sources for the energy production. Electric power plants have become the largest consumer of coal. In the past few years difficulties arose with the use of coal. They are primarily caused by the new regulations concerning environmental protection. The use of sulfur-containing coal has been coupled with the demand to install desulfurization systems which are costly and not yet sufficiently developed. This fact has brought coal in close competition with nuclear power. Despite this, however, it is forecast that the coal consumption by power plants will further rise until the turn of the century, when it will begin to go down. (Air Pollut. Contr. Asso. Abstr.)

Radioactivity Transport and Monitoring

Refer also to abstracts 30748 and 31633.

31007 (KFK-1543) ENVIRONMENTAL ASPECTS OF ^{129}I. Koenig, L. A. (Kernforschungszentrum, Karlsruhe (West Germany)). Jan 1972. 7p. (In German). Dep. NTIS (U. S. Sales Only).

The ^{129}I burden in the environment was studied. It was found that environmental contamination by this radionuclide is due almost exclusively to the release from reprocessing plants, while the release from reactors was immeasurably small under normal operation (<1 nCi/μ). It is recommended that environmental monitoring for ^{129}I be started now, although the ^{129}I level is in general still far below the limit of the permissible burden. (auth)

31008 (PEL-216) ENVIRONMENTAL RADIOACTIVITY AT THE NATIONAL NUCLEAR RESEARCH CENTRE, PELINDABA. Report for the Year 1970. van As, D.; Vleggaar, Constance M. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Sep 1971. 21p. Dep. NTIS (U. S. Sales Only).

A revised environmental survey program, with the emphasis on monitoring of the critical paths of exposure of the general public, was introduced during the period. Results of determinations of both gross radioactivity and of individual nuclides in samples of fish and water (which are critical materials for liquid effluent releases) from the Hartbeespoort Dam and from the Crocodile River, are given and discussed. Results of gamma-spectrometric and ^{90}Sr analyses of milk, which is the critical material for releases to the atmosphere, are presented. Results of regular investigations of the composition of effluent releases, which are performed in order to be able to detect possible other critical nuclides, are given. Levels of deposited and airborne activity from nuclear bomb tests are reported. (auth)

31009 RADIOACTIVE SUBSTANCES IN THE BIOLOGICAL ENVIRONMENT. Huber, Otto (Univ., Fribourg, Switzerland). Praeventivmedizin; 15: No. 3, 189-95(1970). (In German).

Extensive γ-spectroscopic measurements of the radionuclide concentrations of the total biological environment (air, water, milk, bones, body burden, fallout) of Switzerland were made from 1962 to 69; ^{90}Sr, ^{137}Cs, and ^{3}H data are given for 1966. The γ activities determined are considerably less than the maximum permissible concentrations. (Euratom)

Atmosphere

Refer also to abstracts 30655, 30737, 31067, 31368, and 31381.

31010 (CEA-R-4280) PRACTICAL AND GENERAL METHOD OF CALCULATION FOR FORECASTING POLLUTION CARRIED BY THE ATMOSPHERE. Doury, Andre (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Feb 1972. 37p. (In French). Dep. NTIS (U. S. Sales Only).

An automatic, convenient, and economic method is proposed for solving most of the problems concerning the transport of pollution by the atmosphere. The method was developed from a synthesis of a large quantity of specialized work. The fundamental physical principles are simple and logical and the model can be continuously improved and adapted to fit the experimental conditions; this can be accomplished by a simple adjustment of the values of a small number of parameters without modifying the form of the model. A unique analytical solution, valid for an instantaneous elementary source (not necessarily a point source), is used to obtain results for any type of source within confidence limits compatible with the measurement methods. The types of meteorological conditions which must be considered have been reduced to a necessary minimum, which is probably sufficient for current applications. All the operations (pollution forecast, improvements to the model, etc.) can be treated after an operational time delay by a computer having a passive storage. (auth)

31011 (HASL-TM-71-15) DETERMINATION OF THE WORKING LEVEL OF RADON DAUGHTERS BY THE MODIFIED TSIVOGLOU METHOD. Thomas, Jess W. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Jul 1971. 14p. Dep. NTIS.

Equations are presented for calculation of working levels for 5 and 10 min sampling times, together with equations for calculating the standard deviation of the measurements. (M.C.G.)

31012 TRACE ELEMENTS IN THE PRECIPITATION OF THE ALAZANI VALLEY. Supatashvili, G. D.; Kartsivadze, A. I.; Abesalashvili, L. Sh.; Karsanidze, N. K. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR; 66: No. 1, 120-4(Apr 1972). (In Russian).

The content of the trace elements B, F, P, As, Fe, Ni, Cu, Zn, Br, I, and Pb has been determined in the precipitation of the Alazani Valley. The range of their variation in the precipitation has been ascertained, as well as regularities. (auth)

31013 SEASONAL EXTREMES OF THE CONCENTRATION OF FISSION PRODUCTS IN THE ATMOSPHERE. Shem'i-Zade, A. E. At. Energ. (USSR); 32: No. 4, 350-2(Apr 1972). (In Russian).

The concentration of fission products in the lower troposphere in the region of Tashkent (Uzbekistan) was monitored from 1963 through 1965. A pronounced peak in mid-1963 was noted with rapid decrease immediately afterward, which was followed by a small peak in mid-1964, and an even smaller peak in mid-1965. This pattern is related to the purification of the stratosphere from radioactive products; for the stratosphere the period of time representing a one-half reduction in fission product concentration is 5.7 ± 0.1 months. (K.S.W.)

31014 ACTIVITY AND POTENTIAL α-ENERGY OF ^{222}Rn- AND ^{220}Rn-DAUGHTERS IN DIFFERENT AIR ATMOSPHERES. Jacobi, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin) Health Phys.; 22: No. 5, 441-50(May 1972).

A simple model is described to estimate the activity balance of Rn and ^{220}Rn decay products in a turbulent mixed air volume in the steady-state equilibrium, taking into account the attachment to aerosol particles and the removal of activity by ventilation and wall deposition. On the basis of this model the principal relationships between these parameters and the degree of radioactive disequilibrium, the fraction of free atoms or ions and the concentration of potential α-energy in the air are calculated and discussed, especially with regard to the conditions in uranium mines. The concept of potential α-energy is transferred also to ^{220}Rn daughters. The results will be a useful guidance to estimate the relation between the inhaled potential α-energy and the lung dose of workers in uranium and fluorspar mines. (auth)

Soil

31015 (CEA-R-4274) PRACTICAL USE OF THE DISTRIBUTION COEFFICIENT IN MEASURING THE RADIOACTIVE CONTAMINATION OF MINERALS, ROCKS, SOIL, AND UNDERGROUND WATER. Rancon, Daniel (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Mar 1972. 35p. (In French). Dep. NTIS (U. S. Sales Only).

The uptake of radioisotopes by soils or the diffusion in subterranean waters is often estimated with the distribution coefficient (Kd) of the radioisotope between the solution and the solid. In practice, many precautions have to be taken so that the Kd measurements will be representative of natural media. As a matter of fact, the Kd depends on the chemical form of the radioisotope, on the nature and composition of the solution and on the nature of the minerals constituting the rock. But it is also necessary to take into account the texture and the grain size of the material. The Kd does not represent a physicochemical characteristic when applied to consolidated rocks of very low permeability, since it is dependent upon specific surfaces according to a determined law. Accordingly, an alternative concept has been defined for uptake by rocks of this nature, i.e., the surface distribution coefficient or Kd (S). Experience has shown that the value of Kd (S) was constant and characteristic of a consolidated rock and a radioisotope for a specific contact time. (auth)

31016 (GJO-935-1(Pt.1), pp 74-84) AIRBORNE GAMMA RAY SPECTROMETER: MARK III. Fryer, Glenn E. Jun 1971.
In Nuclear techniques in geology and geochemistry.

The design of the airborne gamma spectrometer Mark III system which provides for analog reduction and display of spectral data is described. A signal flow diagram and itemized parts list are included. (L.C.L.)

Water

Refer also to abstracts 30998 and 31005.

31017 (CXRL-7) CONCENTRATIONS OF ^{210}Pb IN RAINWATER IN AUSTRALIA DURING THE YEARS 1964-1970. Bonnyman, J.; Molina-Ramos, J. (Commonwealth X-Ray and Radium Lab., Melbourne (Australia)). 28p. Dep. NTIS (U. S. Sales Only).

Lead-210 concentration in rainwater at centers in Victoria, Queensland, Tasmania, South Australia, Northern Territory, Western Australia and New South Wales is tabulated on an annual basis. (Australia)

31018 (GJO-935-1(Pt.2), pp 303-10) ^{234}U/^{238}U DISEQUILIBRIUM IN GROUNDWATERS OF CENTRAL TEXAS: A PROGRESS REPORT ON RESEARCH COMPLETED. Kronfeld, Joel. Jun 1971.
In Nuclear techniques in geology and geochemistry.

Samples of ground and surface waters from central Texas were analyzed for U content and ^{234}U/^{238}U ratio. The analysis method and results are presented. Surface U concentrations and isotopic ratios contrasted markedly with subsurface values. In general, surface U concentrations were higher than subsurface and were much closer to isotopic equilibrium. Lake Waco water samples had a ^{234}U/^{238}U ratio of 1.2 and a U content of 0.66 ppM while ground water from beneath the city of Waco had a ratio of 5.6 and U content of 0.07 ppM. Surface waters exhibited between 15 and 40% excess ^{234}U. The ground water samples exhibited between 250 and 1300% relative enrichment of ^{234}U. The factors governing the extreme fractionation were not established. (L.C.L.)

31019 (JPRS-55743) RADIOACTIVITY OF WATERS IN NORTHEASTERN PART OF ATLANTIC OCEAN. Baksheeva, I. P.; Zemlyanoi, A. D.; Markelov, V. N.; Nelepo, B. A. Translated from Okeanologiya; 11: No. 6, 1041-8(1971). 13p. NTIS.

Artificial radioactivity studies were carried out in the northeastern Atlantic from aboard the research vessel Mikhail Lomonosov in 1965 to 1966. Strontium-90 concentrations in the northeastern Atlantic at the end of 1965 and the beginning of 1966 were higher than the average values for the whole ocean and amounted to about 50 disintegrations/minute per 100 liters of surface water. The most intensive transport of radioactive products from the Irish Sea was observed north- and north-eastward along the Hebrides and Orkney Islands. Along with nuclear fragments resulting from nuclear weapon tests, industrial atomic wastes discharged to the ocean are a potent source of radioactive pollution of some areas of the world's oceans. (auth)

31020 DISTRIBUTION OF CESIUM IN SURFACE WATERS OF THE PACIFIC OCEAN. Zudin, O. S.; Nelepo, B. A.; Spiring, A. N.; Trusov, A. G. At. Energ. (USSR); 32: No. 4, 347-50(Apr 1972). (In Russian).

Measurements of ^{137}Cs concentration residing in the surface layers of the Pacific Ocean were made at various locations and at various seasons of the year. From the data a "normalized correlation function" was computed for the purpose of graphical representation of the results. Discussion of the graphs relates to testing of thermonuclear weapons, and handling of waste from the atomic industry. (K.S.W.)

Ecosystems and Food Cycles

Refer also to abstract 31380.

31021 (BMI-171-135) AMCHITKA BIOENVIRONMENTAL PROGRAM. APPLICATION OF PHOTOGRAMMETRIC TECHNIQUES FOR ENVIRONMENTAL SURVEILLANCE OF AMCHITKA ISLAND, ALASKA. Annual Progress Report, July 1, 1969-June 30, 1970. Stephan, Joachim G.; Mercier, Ian M. (Battelle Columbus Labs., Ohio). Mar 1972. Contract AT(26-1)-171. 49p. Dep. NTIS.

Three aerial photogrammetric surveys were made to determine sea otter abundance and distribution at Amchitka Island, Alaska. Kodak Ektachrome Aero Film Type 8443 was found to be particularly useful in these surveys because it renders sea otters black and the sea blue in oblique photography. Results indicate that about 2800 sea otters were in the Amchitka area (out to 5 miles from shore) during the survey period. This estimate was obtained by employing the largest number counted during any survey and increasing this by 15 percent to account for animals that, because of their behavior, were not photographed (diving for food, etc.). Color, infrared color, and panchromatic photography were also used to document the bioenvironmental effects of Milrow, an underground nuclear test conducted on October 2, 1969. Normal color film was found to be superior to other film types for detecting fresh rock falls, soil slides, and turbid waters. Infrared color films yielded the best information about vegetation. Most disturbances were noted on the Pacific coastline. A single large slide (located in Square Bay and involving about 7,[illegible]00 cu yd of rock movement) was noted on the Bering side. There were few other damage sites on that side. (auth)

31022 ^{40}K, U, AND ^{226}Ra LEVELS IN SOME BULGARIAN FOODSTUFFS. Boyadjiev, A.; Keslev, D.; Kerteva, A.; Novakova, E. Sci. Publ., Res. Inst. Radiol Radiat. Hyg.; 3: 21-4(1967).

The levels of potassium-40, radium-226, and uranium in foodstuffs that are common in the Bulgarian diet were measured. The foods studied were milk, meat, apples, pears, prunes, rice, wheat corn, beans, potatoes, cabbage, tomatoes, peppers, onions, and grapes. Samples were asked at 450°C and the ^{40}K, ^{226}Ra, and natural uranium measured. The luminescence method was used for uranium, the emanation method for ^{226}Ra, and a flame photometer for ^{40}K. It was found that differences observed in ^{40}K, ^{226}Ra, and U contents of individual foodstuffs from various areas of the country could be reasonably accounted for by differences in the chemical structure of the sails, their capacity for ion exchange, environmental pH, as well as by the characteristic features in the movement of ground and surface waters. (R.C.K.)

Radiometric Techniques

Refer also to abstracts 30994 and 30997.

31023 (GJO-935-1(Pt.1)) [NUCLEAR TECHNIQUES IN GEOLOGY AND GEOCHEMISTRY.] Final Report. (Rice Univ., Houston, Tex. Dept. of Geology). Jun 1971. Contract AT(05-1)-935. 169p. Dep. NTIS.

Eight sections on nuclear equipment and methods used in geology and geochemistry are presented with emphasis on the design and performance of airborne gamma spectrometers. A separate abstract was prepared for each of 7 sections. One report appeared previously in NSA as 26: 15183. (L.C.L.)

For abstracts of individual sections see: 30995–30997, 31016, and 31024–31026.

31024 (GJO-935-1(Pt.1), pp 85-100) CIRCLE OF INVESTIGATION STUDIES. Duval, Joe Jr.; Cook, Beverly. Jun 1971. In Nuclear techniques in geology and geochemistry.

The initial testing of a model of a low-altitude gamma-spectrometric surveying system is discussed. The model is capable of computing counting rates for various portions of infinite sources and for various detector altitudes. (L.C.L.)

31025 (GJO-935-1(Pt.1), pp 101-53) K/Ar AGE DATES AND U, K GEOCHEMISTRY OF THE GUEYDAN (CATAHOULA) FORMATION OF SOUTH TEXAS. Duex, Timothy W. Jun 1971. In Nuclear techniques in geology and geochemistry.

Four Ar/K age dates on biotite separated from the Gueydan produced results ranging from Middle or Late Eocene to Early Oligocene. These ages are somewhat older than was previously hypothesized (Oligocene-Miocene). However, it is believed that there has been no significant reworking of biotite and/or leaching of K from the biotite, either of which would increase the apparent age. These ages are thought to be correct, but, because of the complex stratigraphy, younger ages could also be possible. The Th, U, and K averages yielded results which are somewhat lower than they should be if the Gueydan is inferred to be an acidic volcanic rock originally. The lower averages are thought to be due to leaching and therefore the Gueydan was not originally deficient in these radioelements. The Th, U, and K distribution within the Gueydan approximates a log normal distribution, with minor fluctuations. (auth)

31026 (GJO-935-1(Pt.1), pp 154-61) LABORATORY GAMMA-RAY SPECTROMETER CALIBRATION. Duval, Joe Jr.; Barretto, Paulo; Schwarzer, Rudy. Jun 1971. In Nuclear techniques in geology and geochemistry.

Two methods for calibrating a laboratory gamma spectrometer for determining the potassium, thorium, and uranium contents of rocks and soils are discussed and compared. (L.C.L.)

31027 (GJO-935-1(Pt.2), pp 170-288) ^{222}Rn EMANATION FROM ROCK, SOILS, AND LUNAR DUST. Barretto, Paulo M. C. Jun 1971. In Nuclear techniques in geology and geochemistry.

The radon-222 emanation rate and the escape-to-production rate ratio were measured by alpha counting. The material was analyzed for different grain sizes, moisture, contents, and temperatures. Radon escape-to-production rate ratios from 1% to 25% were found for rocks crushed to identical grain size classes and distinctly higher values, from 20% to 70% were observed in soils. The results permit subdivision of the natural materials at the earth's surface into three categories: strong emanators, soils at 40% radon escape-to-production rate; moderate emanators, igneous rocks at 10% to 15%; and poor emanators, sediments and some metamorphic rocks at 5%. The factors controlling the emanation rate are: grain size; nature matrix or groundmass; uranium distribution within the crystalline structure; crystal damage resulting from radiation; and/or weathering. Radiation damage has been put forward as a plausible mechanism to explain the phenomena on fresh grains because diffusion through the crystal structure alone cannot account for the observed values. Daily temperature variations had no effect on the escape rates as no appreciable adsorption or release of radon was observed in the temperature range of −15 to 96°C. The general effect of moisture is a slight increase in the emanation rate. An escape-to-production rate ratio of 45 ± 20% was observed for 0.4 g of an Apollo 12 dust. The radon isotopes diffusion through the surface rubble and lunar "atmosphere" and the consequent "fallout" of lead isotopes over the moon surface could provide a mechanism for lead enrichment and depletion which might be related to the uranium-lead discordant ages for fines compared to associated rocks. (auth)

31028 TWO-PROBE SYSTEM OF GAMMA-GAMMA WELL LOGGING FOR STUDYING THE EFFECTIVE ATOMIC NUMBER AND DENSITY OF ROCK DENSITIES. Artsybashev, V. A.; Ivanyukovich, G. A. Geofiz. App.; No. 46, 71-3(1971). (In Russian).

A two-probe system includes a ^{137}Cs source and two scintillation detectors at distances R_1 and R_2 from the source. 3-mm filters of Al and Pb, respectively, cover the nearest and furthest detectors. The ratio of the integral counting rates recorded by a detector uniquely determines the atomic number of a rock for an appropriate choice of R_1 and R_2. Thus the apparatus may be used to measure the effective atomic number of a rock or ore in the range of 10 to 25, where $R_1 = 27.7$ and $R_2 = 31.0$ cm, and to determine the density according to the readings of the large probe. (tr-auth)

31029 BOREHOLE APPARATUS WITH A PROPORTIONAL COUNTER FOR X-RAY RADIOMETRIC WELL LOGGING OF UNDERGROUND CREVICES. Mitov, V. N.; Leman, E. P.; Ochkur, A. P.; (and others). Geofiz. App.; No. 46, 50-3(1971). (In Russian).

A proportional counter was developed with a hemi-cylindrical form (12 mm radius). A borehole apparatus with this type of counter offers the possibility of conducting a multicomponent analysis of polymetallic ores during the excitation of characteristic x radiation of certain elements by one gamma source. (tr-auth)

31030 STABILIZATION OF READINGS OF A GAMMA–GAMMA DENSITY METER WITH A SCINTILLATION COUNTER. Pavlov, L. S. Geofiz. App.; No. 46, 123-6(1971). (In Russian).

A reliable method for read-out stabilization of radiometric equipment with scintillation counters involves compensation of the destabilizing factors with the aid of control measurements. Stabilization of gamma–gamma density meters may be achieved, using as the controlling operator a source whose radiation is directed through a special canal onto the crystal of a counter. The principles of stabilizing by the operating counter are discussed, and the requirements which must be complied with are given. By orienting the control canal and placing a diffuser of dense material at its exit, it is possible to achieve effective compensation of equipment error for surface gamma–gamma density meters with a ^{137}Cs source. (tr-auth)

31031 DISTINGUISHING MODERN FROM RELICT WEATHERING PROFILES. Dasch, E. J. (Oregon State Univ., Corvallis); Hills, F. A. Nature (London) Phys. Sci.; 236: No. 66, 73(3 Apr 1972).

It is stated that it is often difficult to establish from geological criteria whether a weathering profile was formed in the recent past or whether it is a relict from a previous weathering regime. The application of the Rb–Sr ratio method to this problem is discussed. Sr is significantly and progressively removed from rocks undergoing moderate weathering, whereas Rb is not appreciably removed until more advanced stages are reached. A wide range in the ratio of Rb to Sr is thereby produced in the weathered profile, and zones with this wide range are datable by Rb–Sr isochron techniques provided, first, that the weathering process leads to a material that initially has a uniform Sr isotope composition, and, second, that subtractions or additions of Rb and Sr effectively cease at the end of a relatively discrete period of weathering. These conditions are discussed. Rb/Sr and ^{87}Sr/^{86}Sr systematics may, however, still provide a qualitative test of the age of a weathered profile even if the conditions described are not met. Very ancient profiles—even those undergoing active weathering at present and therefore not strictly datable—should show a positive, though possibly non-linear, correlation between Rb/Sr and ^{87}Sr/^{86}Sr, whereas recently and rapidly formed profiles should show uniform ^{87}Sr/^{86}Sr throughout. (UK)

31032 FIELD EXPERIMENTS ON THE APPLICATION OF NEUTRON ACTIVATION TECHNIQUES TO IN SITU BOREHOLE ANALYSIS. Landstrom, Ove (Aktiebolaget Atomenergi, Nykoeping, Sweden); Christell, Roland; Koski, Keijo. Geoexploration; 10: No. 1, 23-39(Feb 1972).

Field experiments were performed in the Aitik open pit copper mine with the aim of investigating the possibility of in situ borehole determination of copper as well as other elements by neutron activation techniques. A 10 Ci ^{210}Po–Be source was used for the neutron irradiations and the activation methods were tested in both 46 mm diamond-core drilled holes and 250 mm production holes. The results of the borehole measurements were compared to the core analyses. Borehole gamma-ray spectra from the different radionuclides (^{28}Al, ^{108}Ag, ^{110}Ag, ^{137m}Ba, ^{64}Cu, ^{66}Cu, ^{56}Mn and ^{24}Na) were recorded and the methods of copper determination were especially studied in a copper-rich zone. It turned out that, in the low-grade Aitik ore, it is difficult to base the copper determination on the short-lived isotope ^{66}Cu owing to disturbance from ^{28}Al and ^{56}Mn and from the high background of radon products present in the borehole water. Radon caused a short-time variation in the background and made the use of decay measurements for identification difficult. Higher sensitivity can probably be obtained by using the long-lived isotope ^{64}Cu. The main disturbing nuclide is in this case ^{24}Na if the short-lived nuclides are allowed to decay. It was concluded that in the case of the Aitik ore a stronger neutron source is needed in order to increase the sensitivity, shorten the irradiation time and decrease the disturbance effect from radon. (auth)

31033 COMPENSATED DENSITY LOGGING SYSTEM HAVING A FILTER ONLY ON THE SHORT-SPACED DETECTOR. Wilson, Billy F. (to Dresser Industries, Inc.). U. S. Patent 3,654,470. 4 Apr 1972. Filed 9 Dec 1969.

A well logging instrument having a gamma ray source, a short-spaced gamma ray detector, and a long-spaced gamma ray detector is coupled through a logging cable to surface electronics. A cadmium filter is used to alter the response of the short-spaced detector. This filter causes the relationship between the counting rates measured by the long-spaced detector and the short-spaced detector as the mud cake thickness is varied to be a straight line rather than a curved line when plotted on log–log graph paper. Filters composed of tin, silver, copper, nickel or iron, individually or in combinations, may be used in place of cadmium. Such straight line relationships are useful in determining true formation densities from the two counting rates. (Official Gazette)

31034 RESONANT SCATTERING OF GAMMA RAYS AS SELECTIVE MEANS FOR DETERMINING AN ELEMENT OF INTEREST. Johnson, Walter H. Jr.; Pritchett, William C. (to Atlantic Richfield Co.). U. S. Patent 3,654,464. 4 Apr 1972. Filed 22 Jan 1970.

A radioactive logging method and apparatus are described for quantitatively determining an element of interest in subsurface formations traversed by a borehole. Earth formations are bombarded with fast neutrons causing the various elements to emit characteristic gamma rays. These gammas strike resonant scatter material which is specially selected to elastically scatter only those gammas derived from the element of interest. The scattered gammas thus obtained are detected with a scintillator and a photomultiplier. (Official Gazette)

31035 APPLICATION OF NATURAL ISOTOPES IN GROUND WATER HYDROLOGY. Mook, W. G. (Univ. of Groningen, Netherlands). Geol. Mijnbouw; 51: No. 1, 131-6(1972).

^{18}O, deuterium and tritium may serve as tracers and be used to determine the origin of groundwater. The radioactive isotopes ^{14}C can be used to date water. Deuterium and ^{13}C may give information about evaporation and processes in the unsaturated zone. (auth) (Netherlands)

Site Surveys

31036 (BNWL-B-1) FFTF SITE METEOROLOGY. Progress Report No. 1. Daubek, H. G.; Wolf, M. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sep 1970. Contract AT(45-1)-1830. 171p. Dep. NTIS.

Studies of trajectories and diffusion and meteorological summaries show the differences in the values of meteorological parameters measured in and adjacent to the southern portion of the Hanford Reservation. Soundings of temperature, humidity, and wind velocity were made to supplement the horizontal network of sensors. Tetroon trajectories were used to simulate the trajectories of air parcels. Tetroon trajectories were consistent with motions expected from the temperature profiles and winds measured above the surface. The climatic studies show differences in wind velocity and temperature between the FFTF Site and other locations indicating direct extrapolation of some parameters over long distances on the Hanford Reservation is not practical. (auth)

31037 (DOCKET-50332-25) BARNWELL NUCLEAR FUEL PLANT. Effects of Variations in Soil Moduli on Process Building Soil Springs; Effect of Dewatering Under FRSS Pools. (Bechtel Corp., San Francisco, Calif.). Apr 1972. 50p. Dep. NTIS.

For Allied-Gulf Nuclear Services, Barnwell, S. C.

Theories and data available were used to give results that approximate the response of the process building to an earthquake. A question and answer type format is given, and information on relative effects of averaging soil moduli on structural response, effects of ignoring embedment of surrounding berm, and a combination of the two is appended. (P.C.H.)

31038 (DOCKET-701292-3) FUELS FABRICATION PLANT. Revised Environmental Report, Replacement Pages 246 and 247. (Nuclear Fuel Services, Inc., Rockville, Md.). 28 Apr 1972. 3p. Dep. NTIS.

Dames and Moore plots of recommended response spectra for an acceleration value of 0.15 g for the design basis earthquake and 0.08 g for the operating basis earthquake for the West Valley Fuels Fabrication Plant are given. (P.C.H.)

31039 (DOCKET-701292-4) FUELS FABRICATION PLANT. Environmental Report, Amendment 1. (Nuclear Fuel Services, Inc., Rockville, Md.). 14 Apr 1972. 72p. Dep. NTIS.

Two new developments are included in the amendment. These are: a detailed evaluation of the meteorological characteristics of the West Valley site based on hourly data for the one year period Dec. 15, 1970 through Dec. 15, 1971, which is more accurate than that previously available; and a more precise analysis of the potentially radioactive gaseous and liquid effluents from the Fuel Fabrication Plant. (P.C.H.)

31040 (WASH-1515) RADIOACTIVE SOLID WASTE VOLUME REDUCTION FACILITY, LOS ALAMOS SCIENTIFIC LABORATORY, NEW MEXICO. Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Apr 1972. 89p. Dep. NTIS.

The environmental impact of constructing and operating an engineering demonstration facility for reduction of solid radioactive waste volumes at Los Alamos Scientific Laboratory (LASL) was studied. The facility would be used to study and develop safe and effective sorting, compaction, and incineration procedures for solid wastes contaminated with low levels of radioactive material, particularly Pu as found in typical LASL wastes. An existing building would be modified and expanded to house the facility. No problem is foreseen in the decontamination and removal of the building, if necessary or desirable, at the end of the estimated 4 yr of demonstration operations. After balancing the anticipated benefits against the environmental and economic costs of the proposed facility, the AEC concluded that the proposed solid radioactive waste volume reduction facility should be designed and constructed. (L.C.L.)

31041 (WASH-1518) LAND ACQUISITION, ROCKY FLATS PLANT, COLORADO. Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Apr 1972. 49p. Dep. NTIS.

The environmental impact of acquiring 4,640 acres of land surrounding the existing Rocky Flats Plant in Colorado was studied. The land area sought would provide an approximately 1½-mile-wide buffer zone around the plant. This acreage is presently used for grazing, but could be developed for residential or industrial uses. Preservation of such an undeveloped area agrees with the recommendations of the Colorado State Environmental Commission. No adverse environmental effects are foreseen. The AEC has concluded that the land should be purchased. (L.C.L.)

31042 (WASH-1521) RADIOACTIVE WASTE EVAPORATOR AND AUXILIARIES, RICHLAND, WASHINGTON. Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Apr 1972. 97p. Dep. NTIS.

The environmental impact of the Radioactive Waste Evaporator (RWE) and auxiliaries proposed for solidifying liquid waste at the Hanford plant was studied. The RWE is an evaporator-crystallizer unit capable of processing approximately twice as much liquid waste as the existing three evaporators combined. The auxiliaries would consist of pipelines and equipment modifications to permit existing tanks to be used for the storage of the salt cake residues, facilities to neutralize the excess alkalinity in concentrated liquid waste, and a concentrated waste cooler. Radioactive effluents from the RWE would be discharged to an enclosed trench. Nonradioactive heated cooling water would be discharged to a surface pond in the desert. Data are presented on the unavoidable, probable, and extraordinary environmental effects of the RWE facility, the irreversible and irretrievable commitments of resources, and a cost-benefit analysis. The alternative of continued use of the low-capacity existing equipment is considered. After assessing the anticipated benefits against the cost, and the available alternatives and their environmental effects, the AEC concluded that it should proceed to construct and operate the Radioactive Waste Evaporator and the auxiliaries. (L.C.L.)

31043 (WASH-1515(Dr.)) SOLID RADIOACTIVE WASTE VOLUME REDUCTION FACILITY, LOS ALAMOS SCIENTIFIC LABORATORY. Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Jan 1972. 42p. Dep. NTIS.

The environmental impact of constructing and operating a proposed facility for reducing solid radioactive waste volumes at LASL is reported. The facility would be used to study and develop safe and effective methods for sorting, compacting, and incinerating low-level solid wastes, particularly plutonium-contaminated wastes. The facility would be located in an addition to an existing building within an existing fenced in area and would require only minor changes in current land use. The most adverse accident envisioned is a major fire. Design and operating procedures specifications for minimizing such an accident are included. Information is included on: the facility location and site description; waste handling methods related to the proposed facility; environmental monitoring requirements; probable, extraordinary, and unavoidable adverse environmental effects; alternatives; and cost-benefit analysis. The project involves no irreversible commitment of resources. It is concluded that the proposed solid radioactive waste volume reduction facility should be designed and constructed. (L.C.L.)

31044 (WASH-1521(Dr.)) RADIOACTIVE WASTE EVAPORATOR AND AUXILIARIES, RICHLAND, WASHINGTON. Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Jan 1972. 66p. Dep. NTIS.

The environmental impact of constructing and operating at the Hanford Plant a Radioactive Waste Evaporator and Auxiliaries for converting highly radioactive liquid wastes stored in buried steel-lined concrete tanks into a solid retrievable salt cake residue is reported. The site, facilities, and process are described. The construction and operating costs are presented. The benefits, adverse effects, and alternatives are discussed. It is concluded that the Radioactive Waste Evaporator and Auxiliaries should be constructed and operated. (L.C.L.)

31045 (WASH-1522(Dr.)) PLUTONIUM-238 FUEL FABRICATION FACILITY SAVANNAH RIVER, S. C. Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Jan 1972. 32p. Dep. NTIS.

Facilities for converting ^{238}Pu oxide into compacted shapes for use as fuel in Radioisotope Thermoelectric Generators (RTG's) are described. Background, environmental impact, unavoidable adverse environmental effects, alternatives, irreversible and irretrievable commitments of resources, and cost-benefit analysis are discussed. (T.F.D.)

31046 GEOLOGICAL ENGINEERING EVALUATION OF AN UNDERGROUND NUCLEAR TEST SITE. Sharp, Robert Raymond Jr. Tucson, Ariz.; Univ. of Arizona (1972). 820p. University Microfilms Order No. 72-13,281.
Thesis.

A geological engineering evaluation is presented of conditions related to the use of Amchitka Island, Aleutian Islands, Alaska, as a site for contained high-yield nuclear tests. The evaluation is based on data obtained from field inspection, laboratory tests and study of aerial photographs, as well as pertinent published literature. Containment requires detonation underground so that no significant release of radioactivity results. A high-yield nuclear explosion is one equivalent in energy to at least 10^6 tons of TNT (1 Mt). Yields considered are limited to ten times this amount. Aspects studied include: the geography, bathymetry, sediments and geology of the region of the North Pacific and the Bering Sea; the regional tectonics in light of geophysical data; the seismicity of the region and principal stress directions inferred by seismology; the history, geography, geomorphology, geology and sediments of the Aleutian Islands,' ridge and trench; the geography, geomorphology, geology, geophysics and hydrology of Amchitka Island; the geological engineering properties of Amchitka Island rocks; the general geological engineering characteristics of Amchitka and those peculiar to its use as a nuclear test site; the hazard on Amchitka from volcanic activity, earthquakes and tsunamis; the properties of natural and man-made earthquakes; the seismic energy release from underground nuclear explosions and their aftershocks; the causes and properties of tsunamis and the Pacific Tsunami Warning System; and the prediction of local test-induced effects and possibility of hazards beyond the area of Amchitka Island. The island is evaluated as a test site in view of the above aspects, large underground nuclear explosions in general, and experience from the nuclear tests Longshot (80 kt) and Milrow (1 Mt), fielded there in 1965 and 1969, respectively. Conclusions reached include: Amchitka Island is nearly centered in an extremely remote, undeveloped and largely uninhibited region of uninviting weather; the Aleutian and Bowers ridges, as well as Kodiak Island-Kenai Peninsula on the far east, appear to be basically uplifted, structural wedges; the Aleutian ridge is broken and shattered by forces active in its formation and this should allow some relief of abnormal stresses, resulting in essentially gravity loading within a few miles of the surface along its crest; the Rat Island structural block of which Amchitka is a part appears structurally decoupled from the rest of the Aleutian ridge, the North Pacific and Aleutian basins; there is little hazard from vulcanism, earthquakes or tsunamis on Amchitka since it has no volcanoes, is considerably removed from the major zones of large shallow earthquakes, and is in a portion of the Aleutian arc where the predominant motion of the North Pacific tectonic plate is primarily of a strike-slip nature; Amchitka is marked by glacial, marine and fluvial erosion, controlled by faults and master joints, and exhibits a heterogeneous assemblage of volcanic rocks with secondary alteration which diminishes their fracture-controlled permeability; the island has a geothermal gradient that is slightly low and rocks with intermediate engineering properties indicating them to be generally amenable to elastic analysis but not prone to violent failure; the amount of seismic energy from an earthquake greatly exceeds that from a contained explosion giving the same body wave magnitude; gravitational potential appears to be a more important source of seismic energy from large contained explosions than does tectonic strain; no contained nuclear event has resulted in an aftershock of a size close to that represented by its explosion energy or the small fraction of its explosion energy released as seismic waves upon detonation; the largest rockbursts in mines surpass the largest explosion aftershocks in seismic energy release; there is no historic record of a truly damaging tsunami originating in the Aleutians close to Amchitka or westward; the effects of contained nuclear explosions are predictable within safe limits and experience from tests on Amchitka adds confidence to their local prediction and applicability; at least within the upper limit of yield considered, no significant damage should result on or off Amchitka from properly planned nuclear tests there. (Diss. Abstr. Int., B)

Thermal Effluents

Refer also to abstracts 32797, 32805, 32866, 32872, 32882, and 32897.

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 30619, 30995–30997, 31016, 31024, 31026, 31030, 31033, 32764, and 32768.

General Detectors and Monitors

Refer also to abstracts 31214, 31641, 32343, 32411, and 32911.

31047 (AAEC/TM-593) PULSE HEIGHT ANALYSIS USING A PDP-15 COMPUTER. Tighe, L. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jun 1971. 28p. Dep. NTIS (U. S. Sales Only).

The use of a PDP-15 computer in a pulse height analysis system is described. Both the analog-to-digital converter and the cathode ray oscilloscope display have direct access to the computer memory and hence the only programing required for their control is the setting up of status words. (auth)

31048 (ACRH-1000-314) ASPECTS OF IMAGING AND COUNTING IN NUCLEAR MEDICINE USING SCINTILLATION AND SEMICONDUCTOR DETECTORS. Beck, R. N.; Zimmer, L. T.; Charleston, D. B.; Hoffer, P. B. (Chicago Univ., Ill. Dept. of Radiology. Argonne Cancer Research Hospital, Chicago, Ill.). 1 Mar 1972. Contract AT(11-1)-69. 24p. (CONF-720306-5). Dep. NTIS.

From Scintillation and semiconductor counter symposium; Washington, D. C. (1 Mar 1972).

In the interest of minimizing patient irradiation, while maximizing diagnostic image quality, it is desirable to utilize all of the radiation emerging from the patient. For optimum utilization it appears to be necessary to allow photons with different energies to contribute to the image with different weights. Optimum weights have been determined for the most common case of noise-limited images, where it is assumed that the weights should be chosen so as to maximize the signal-to-noise ratio. For less noisy images, sharpening may be achieved by assigning negative weights to scattered photons; that is, by scatter subtraction. In general, image formation with multiple weighted channels provides a greater degree of flexibility than is possible with a single channel. (auth)

31049 (CALT-767-P-11-X-2) STUDY OF DEEP LEVELS IN DETECTOR-GRADE GERMANIUM BY CHARGE TRANSPORT TECHNIQUES. Report No. 2. Caywood, John Marrello, Vince; Ottaviani, Gianpiero; Mayer, J. W.; Nicolet, M.-A. (California Inst. of Tech., Pasadena. Dept. of Electrical Engineering). 29 Feb 1972. Contract AT(04-3)-767. 3p. Dep. NTIS.

A Baertch and Hall gas discharge system was used for ion implantation in germanium prior to antimony evaporation for forming an n^+ layer at 200°C. The carrier lifetime was 15 μsec compared to 11 μsec for detectors processed at 300°C. (W.H.K.)

31050 (CEA-N-1505) X-RAY IMAGES FROM SPARK CHAMBERS. Morucci, Jean-Pierre; Seigneur, Alain; Lansiart, Alain (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec 1971. 31p. (In French). Dep. NTIS (U. S. Sales Only).

The spark chamber was the first x-ray sensitive stationary detector. Its resolution qualities render it suitable for the display of an ^{125}I labeled thyroid. Comparisons are made with conventional scintigrams for certain clinical results. The x-ray optics is the only factor limiting the resolution; it is for this reason that special collimators were developed, several different techniques being adopted for the different constructions. Several applications for studies with small animals and experiments involving the fixation of transuranic elements are envisaged. (France)

31051 (CEA-R-4271) APPLICATION OF THE MODULATION TRANSFER FUNCTION (MTF) TO DETECTORS WITHIN NUCLEAR MEDICINE. Allard, Gilles (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb 1972. 73p. (In French). Dep. NTIS (U. S. Sales Only).

The MTF is applied to different visualizing systems in nuclear medicine. Its utilization allows both determination of performance obtained with an associated collimator/detector system and comparison, based upon a ratio method, between different designs. This paper is mainly directed to the study of the MTF applied to a spark chamber. In a first part, a theoretical study on the MTF of collimators with circular parallel holes was made; thereafter, the MTF of the detector itself was measured for the following radionuclides: ^{125}I, ^{68}Ge, and ^{197}Hg and in the presence (in the case of ^{125}I only) of the scattered radiation. The "Picker" scanning detector was also investigated with ^{125}I, as well as the scintillation camera with ^{99m}Tc. (40 figures, 11 tables) (auth)

31052 (CERN-71-16(Vol.1 and 2), pp 371-87) DOSE-EQUIVALENT MEASUREMENT IN MIXED RADIATION FIELD: THE TISSUE-EQUIVALENT COUNTER AND PROCESSING OF DATA. Srdoc, Dusan; Breyer, Branko (Institut Rudjer Boskovic, Zagreb (Yugoslavia)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

A tissue-equivalent (TE) proportional counter made of TE plastic enclosed in a thin Al can is described. The properties of the counter of importance for the design and proper functioning of a dose equivalent or quality factor meter are considered, along with the required electronics and a reliable method of counter calibration. Event size spectra for ^{60}Co radiation and 1 μm tissue size are shown for this cylindrical counter and the Rossi spherical counter; the results agree within experimental errors. It is concluded that several long-standing problems in practical methods of measurement of dose equivalent, such as the construction of a relatively simple TE counter and the associated electronics, can be overcome; however, a straightforward utilization of the output data from a TE proportional counter for radiation quality measurements is hampered by existing ICRP recommendations. (5 figures) (R.W.R.)

31053 (CERN-71-16(Vol.1 and 2), pp 388-402) NE 102A ORGANIC SCINTILLATOR AS AN ACCEPTABLE LET-DEPENDENT DETECTOR FOR QUALITY FACTOR AND DOSE EQUIVALENT DETERMINATIONS IN MIXED RADIATION FIELD. Pszona, S. (Institute of Nuclear Research, Swierk (Poland)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

An organic scintillator can be considered as an oversimplified model for study of physical processes that take place in tissue under irradiation, from the point of view of radiation protection. The LET response of the PVT (polyvinyltoluene) plastic scintillator NE102A exposed to mixed radiation of several types of charged particles is discussed, and experimental data on quality factor and dose equivalent determination in low- and high-energy radiation (~10-MeV neutrons and 196-MeV protons) by use of this scintillator in a conjugate detector system are presented. A portable instrument for dose equivalent rate determinations based on the method described was compared with the "recombination" method in the mixed stray radiation field near high-energy proton and electron accelerators, and good agreement was obtained. (8 figures, 1 table) (R.W.R.)

31054 (CERN-71-16(Vol.1 and 2), pp 444-59) STANDARD FREE-AIR CHAMBER WITH MAGNETIC FIELD FOR GAMMA RAYS UP TO 50 MeV. Joyet, G. (Universitaetsklinik und Poliklinik fuer Radiotherapie und Nuklearmedizin, Zurich (Switzerland)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The standard free-air ionization chamber can be used to measure exposure dose for x-ray energies only to about 500 keV. Such a chamber of conventional size can be used for gamma rays up to 50 MeV by build-up of the secondary electrons in a filter of solid air-equivalent material and confinement of the electron flux between the capacitor plates with an axial magnetic field. Choice of the proper magnetic field and the best air-equivalent materials is discussed. (5 figures, 4 tables) (R.W.R.)

31055 (CERN-71-16(Vol.1 and 2), pp 966-79) MONITORING SYSTEM FOR MEASURING THE DOSE-RATE FROM INDUCED ACTIVITY IN HIGH-ENERGY ACCELERATORS. Schoenbacher, H.; Sullivan, A. H.; Baarli, J. (European Organization for Nuclear Research, Geneva (Switzerland)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

A radiation monitoring system, using Geiger–Mueller counters, for the CERN ISR is described. The design and calibration of the detector, the readout system, and the performance of prototypes are discussed. During machine operation the detector is exposed to high-energy radiation, which induces radioactivity in the tube itself; as a result, the detector overreads by a factor of two (at most). The system should have the ability to show the distribution of induced radioactivity in the ISR tunnel and to indicate the places where more detailed survey measurements must be made. (3 figures, 2 tables) (R.W.R.)

31056 (EUR–4775(Pt.1)) COLLECTRONS, SELF-POWERED NEUTRON FLUX DETECTORS. PART I. THEORETICAL CONSIDERATIONS. Grin, M. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 5 Jan 1972. 38p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 60.-.

Collectrons are self-powered neutron flux detectors based on the direct collection of electric charges emitted from a short lived β emitter activated by neutron flux. After a short description of components and measuring circuits, the theoretical sensitivity of the collectrons is studied. An evaluation of self shielding and the flux depression factor and the self absorption factor leads to the formulation of the theoretical sensitivity of the collectrons in normal working conditions. The cases of rhodium, silver and vanadium are considered. (auth)

31057 (EUR–4775(Pt.2)) COLLECTRONS, SELF-POWERED NEUTRON FLUX DETECTORS. PART II. IRRADIATION TESTS AND CALIBRATION IN ISPRA-1. Debeir, R. P.; Grin, M.; Simoni, O. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 5 Jan 1972. 54p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 70.-.

Collectrons are self-powered neutron flux detectors based on the activation of short life beta sources by the neutron flux itself. The first part of this report is devoted to the description of the devices and to the computation of their theoretical sensitivity with particular reference to some correcting factors such as neutron self-shielding and β self-absorption. The second part deals with the behavior of the collectrons in normal working conditions. During a series of irradiation tests the following points have been examined: calibration of various β emitters and comparison with theoretical values; study of the wiring and background compensation; and relative influence of thermal and epithermal flux on the output current of the detectors. The calibration values obtained are in very good agreement with theoretical computations. Also, an analysis of the equivalent electrical circuit of a collectron is given. (auth)

31058 (EURFNR–963) SIMPLE PULSE SHAPE DISCRIMINATOR. Bandl, R. E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Translation of report KFK–1458. 12p. Dep. NTIS.

Work performed under United States–Euratom Fast Reactor Exchange Program.

A simple pulse shape discriminator was developed to separate neutron and γ-ray pulses from a fast scintillator system. The zero-crossing method is employed by measuring the time difference between the fast signal from the photomultiplier anode and the zero-crossover of a doubly-differentiated pulse from a suitable dynode. The arrangement was tested using a large sensitive area photomultiplier coupled with a NE 213 liquid scintillator. The γ-ray suppression capability of the discriminator is demonstrated both with an Am–Be source and with neutron induced fission. The system is especially suited to neutron time-of-flight experiments. (auth)

31059 (FRNC-R–3) LIQUID-FILLED IONIZATION CHAMBERS: FLUORESCENCE DECAY OF RADIOPHOTOLUMINESCENT GLASS. Annual Progress Report, 1970. (Toulouse Univ. (France). Centre de Physique Atomique et Nucleaire). 114p. (In French). Dep. NTIS (U. S. Sales Only).

The conduction induced by γ radiation from ^{60}Co in CCl_4–hydrocarbon mixtures and mixtures of 2,2,4-trimethylpentane with various compounds having an electronegative character, such as $SiCl_4$, and $GeCl_4$, and cyclo $C_8F_{16}O$, were studied. The free ion yield at zero field per 100 eV absorbed and the mean thermalization distance for epithermal electrons are linked to the ionization current of the alkane and its inhibition by an electron capture compound; the electron affinities of the various inhibitor compounds used are subsequently introduced. The response of plane or cylindrical ionization chambers filled with a liquid dielectric (pure alkane or a CCl_4–alkane mixture) to a single radiation pulse or several pulses (electrons or bremsstrahlung) was studied as a function of the duration, frequency, and intensity of the pulses. In addition, the depth dose distribution was measured for a plexiglas phantom irradiated with a beam of monoenergetic electrons having energies between 1 and 30 MeV. (France)

31060 (KFKI–72–11) EMPIRICAL FORMULA FOR THE CALCULATION OF THE FULL ENERGY PEAK EFFICIENCY OF A 6" x 4" NaI(Tl) CRYSTAL DETECTOR FOR POINT SOURCES. Andrasi, A.; Koetel, G. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Feb 1972. 12p. Dep. NTIS (U. S. Sales Only).

The determination of empirical formulas suitable for describing the full-energy-peak efficiency of a scintillation detector is considered for the case in which the position and energy coordinates of a point source are known. The calculations were made for the 6 × 4 in. NaI(Tl) detector of the NS-206 whole-body counter at the CRIP. Two- and three-variable functions were obtained by successive application of single-variable approximations on the basis of efficiency measurements carried out on standard gamma point sources. In the 0.5 to 2.0 MeV range the error of the efficiency calculated with the three-variable formula is expected to be <5%. To increase the applicability of these formulas a method for computerized calculation of the functions was worked out that is suitable for inclusion in Algol programs. (1 figure, 3 tables) (auth)

31061 (NP–19263) PROPOSAL FOR INSTALLATION OF A THREE-PARAMETER FISSION EXPERIMENT AT THE HFR GRENOBLE. Horsch, F.; Michaelis, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). May 1970. 10p. Dep. NTIS (U. S. Sales Only).

It is proposed to install a three-parameter fission experiment at the HFR Grenoble for the investigations of very short-lived prebeta decay transitions in primary fission fragments. The instrument will be a valuable completion of the recoil mass spectrometer already under construction at the HFR. Main components of the setup will be two Si surface-barrier detectors for the measurement of the correlated fragment energies and a Ge(Li) gamma-ray detector. The data will be on line processed and stored via the Grenoble NICOLE system. (auth)

31062 (ORO–2401–58) COMPARISON OF THE RESPONSE CHARACTERISTICS OF A LITHIUM-DRIFTED GERMANIUM DETECTOR AND A SODIUM IODIDE DETECTOR SCANNING SYSTEM. Rolfes, Richard G. (Vanderbilt Univ., Nashville, Tenn.). Dec 1971. 81p. Dep. NTIS.

Thesis.

A direct comparison of the response characteristics of two radioisotope scanning systems equivalent in all respects except that one incorporates a high energy resolution 16 mm diameter Ge(Li) radiation detector while the other uses a 1.5 inch diameter NaI detector is presented. The line spread responses of the two systems to ^{99m}Tc and ^{197}Hg sources in air and in water at a number of distances from the collimator face were measured. The modulation transfer functions corresponding to the line spreads were calculated. The responses of the two systems to a volume activity-non-activity interface of ^{99m}Tc and ^{197}Hg were also measured. The high energy resolution of the Ge(Li) detector allowed this system to ignore all but small angle scattered radiation. The scatter fractions accepted by the Ge(Li) system were approximately a factor of 10 smaller than those accepted by the NaI system. As a result, the Ge(Li) system was clearly superior to the NaI system in spatially resolving radiation distributions in a scattering medium. The sensitivities of the two systems differed by a factor of approximately 3 for ^{99m}Tc and by a factor of 4 for ^{197}Hg in favor of the NaI system. According to the figure of merit criterion, the NaI system was better than the Ge(Li) system for general scanning purposes. (auth)

31063 DISCRIMINATION BETWEEN LIGHT ISOTOPES USING A (E,ΔE) JUNCTION TELESCOPE AND SCINTILLATORS. Alard, J. P. (Univ., Clermont-Ferrand, France); Avan, Louis; Avan, Madeleine; (and others). Compt. Rend., Ser. B; 274: No. 3, 196-9 (17 Jan 1972). (In French).

The SC33 experiment undertaken at CERN is described. This experiment facilitated a systematic study of the fragmentation of nuclei bombarded with 600 MeV protons. The results concerning the identification of low and high energy particles are examined. (France)

31064 LUMINOUS RADIATIONS IN A PROPORTIONAL COUNTER. Albul, V. I.; Baranov, V. G. Meas. Tech. (USSR) (Engl. Transl.); 14: No. 10, 1569-70(Oct 1971).

Translated from Izmer. Tekh.; 14: No. 10, 67(Oct 1971).

The counting characteristics of a photomultiplier readout system operating with a propane-filled proportional counter were studied. The counting rates from the photomultiplier and from the proportional counter are plotted as a function of the operating voltage of the proportional counter, and the counting rates coincide. Possible applications of this combination of proportional counter with additional photomultiplier readout are briefly discussed. (W.H.K.)

31065 RADIATION PROTECTION INSTRUMENTATION AND ITS APPLICATION. ICRU Report 20–1971. Washington, D. C.; International Commission on Radiation Units and Measurements (1971). 64p.

A basic discussion of radiation quantities and units, the interpretation of instrument readings in terms of such units, and the accuracy usually required is given. Characteristics of ionization chamber instruments, gas proportional counters, Geiger–Mueller counters, scintillation counters, photographic devices, and solid state and activation devices are briefly described. The choice and use of instruments for surveying, area monitoring, and environmental monitoring when dealing with sealed gamma-ray sources and sources of x rays and electrons, unsealed radioactive sources, reactors and sealed neutron sources, and charged particle accelerators are discussed. Also, the choice and use of instruments for individual monitoring are considered. Finally, instrument calibration procedures are discussed. (209 references) (W.H.K.)

31066 NATURE AND CONTROL OF EXTERNAL SOURCES OF VARIATION IN WHOLE-BODY COUNTING. Walker, William Jefferson Jr. Gainesville, Fla.; Univ. of Florida (1971). 227p. University Microfilms Order No. 72-12,999.

Thesis.

Variations from a wide range of sources can decrease the precision of measurements made with a large-volume liquid-scintillation whole-body counter. External variables include: 1) radiations other than those being measured, including natural background and human potassium-40 (^{40}K) and cesium-137 (^{137}Cs); 2) the subject size and shape and their realistic simulation, and; 3) variations resulting from operational procedures and techniques. The reduction in variance of whole-body radioisotope measurements due to these variables was the primary objective of this research. The major applications of the University of Florida whole-body counter have been measured of natural ^{40}K in the human body and studies involving trace metal metabolism. The low levels present in ^{40}K measurements make them particularly susceptible to the influences of external variables. Radon-222 (^{222}Rn) daughter products were identified as a major source of variation in low-level measurements. These were deposited in a non-uniform fashion on clothing worn by subjects during counting, on phantoms, and on detector surfaces. Additionally, the total activity often changed drastically within a short time due to decay and other factors. Partial control was achieved by recirculating air in the whole-body counter room through an absolute filter to remove daughter products of the ^{222}Rn. Further reduction in variation due to this source was accomplished by protecting phantoms and subject clothing from exposure to ^{222}Rn daughters and filtering air supplied to the counter shield. A unique phantom to simulate human subjects was designed for maximum flexibility, convenience, and economy while providing a practical and precise standard for calibration of the counter. The phantom is composed of multiple, two-inch diameter polyvinyl chloride (PVC) cylinders. Each cylinder is filled with sugar and sealed. A standard man phantom is composed of 105 cylinders, arranged in seven groups. A wide range of body sizes and geometries is possible by varying the cylinder length within these groups and the number of cylinders, and many radioisotope distributions may be simulated. The radioisotope is contained in PVC tubes, one centimeter in diameter, which are placed in the interstice formed between any group of three cylinders. Counting routines were carefully evaluated and modified for elimination of sources of variation. These routines were selection of measurement windows and other operating procedures, counting times, counting procedures, and subject handling. The application of these methods for controlling external variables now makes possible the measurement of total-body potassium content with a precision of ±two percent at the ninety-five percent confidence level with a ten-minute counting time. (Diss. Abstr. Int., B)

31067 AUTOMATED ATMOSPHERIC RADON SAMPLING SYSTEM. Thomas, J. W. (Atomic Energy Commission Health Protection Engineering Div., New York). Atmos. Environ.; 6: No. 4, 285(Apr 1972).

In a paper by Newstein, Cohen and Krablin (Atmos. Environ.; 5: 823 (1971) the authors demonstrated the utility and high sensitivities obtainable using the two filter method for radon. However it was claimed in that paper that the flow does not need to be monitored since small variations (20 to 30%) are not important. It is claimed in this article that such a statement could be misleading since the diffusion losses of the daughter products formed in the chamber are a function of flow rate, and if the losses are high, a change of flow rate of 30% could cause a change of about 30% in diffusion losses. (UK)

31068 OBSERVING PROTON TRACKS IN CELLULOSE NITRATE. Carpenter, B. S.; Lafleur, P. D. (National Bureau of Standards, Washington, D. C.). Int. J. Appl. Radiat. Isotop.; 23: No. 4, 157-9(Apr 1972).

Cellulose nitrate was used as a detector to observe monoenergetic proton tracks. These monoenergetic protons are produced from a ^{14}N source placed in contact with the detector and irradiated in a thermal-neutron flux. After irradiation the detectors were chemically etched to produce optically visible tracks. (auth) (UK)

31069 RADIATION DETECTION. Peacock, Anthony (to Imperial Chemical Industries Ltd.). British Patent 1,269,635. 6 Apr 1972. Filed 18 Jun 1968.

The invention described comprises a unit for converting a low voltage DC input to high voltage DC fed through a high resistance, constituting an output suitable for feeding to a GM radiation sensing instrument. The unit is potted entirely in insulating material. A battery may be used as current source. The unit has a low tendency to sparking and is thus suitable for use in inflammable atmospheres. The method of use with a GM instrument is described. (UK)

31070 IMPROVEMENTS IN OR RELATING TO RADIATION DETECTORS. Wankling, James Leonard; Ellis, Ronald (to National Research Development Corp.). British Patent 1,269,634. 6 Apr 1972. Filed 12 Jun 1968.

Reference is made to γ-ray detectors of the semiconductor type suitable for use in γ-ray cameras. The detector described comprises a slab of semiconductor material having first and second regions of opposite conductivity types formed on opposite sides of the slab with an intrinsic region between them. The slab is provided with slots which divide its sides into parallel ribs, the ribs on one side of the slab being aligned transverse to those on the other side. The arrangement is such that the junctions between the intrinsic region and the first and second regions lie within the ribs, and means are provided for making electrical connection to each of the ribs. A γ-camera is also described employing the foregoing type of detector (Ge). Means are provided for applying a bias voltage between the ribs on opposite sides of the slab, together with circuit means operable by pulses produced by γ-rays incident to the detector to indicate at which portion of the intrinsic region a γ-ray was incident. A method for fabricating the detector is also described. Means are provided for maintaining the temperature of the detector at a predetermined low value. (UK)

31071 USE OF A GAMMA-CAMERA AS A WHOLE-BODY COUNTER. Short, M. D.; Richards, A. R.; Glass, H. I. (Hammersmith Hospital, London). Brit. J. Radial.; 45: No. 532, 289-93(Apr 1972).

The properties of a gamma-camera used as a whole-body counter for radioisotope retention studies are described. Optimum operating conditions for ^{57}Co, ^{58}Co and ^{59}Fe were determined and the use of an uncollimated gamma-camera was shown to provide the best sensitivity. Using a phantom, the dependence of sensitivity on distribution of activity was shown to be within ±4% of the true value which is acceptable for most clinical studies. This was achieved by observing the count as the gamma-camera was moved vertically in front and then behind the patient. The use of an "end-pause" technique was shown to improve the uniformity of response of the system, and the mean between the arithmetic and geometric mean count rates was used to calculate the net retention. (UK)

31072 FACTORS AFFECTING TOTAL FISSION CROSS SECTION MEASUREMENTS USING SOLID STATE TRACK DETECTORS. Iyer, R. H.; Sampathkumar, R. (Bhabha Atomic Research Centre, Trombay, India). pp 301-9 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

The powerful technique of fission fragment track registration on insulating materials like mica, lexan etc., and subsequent counting of these tracks under an optical microscope is being used increasingly for a variety of studies in nuclear fission. In an attempt to extend the usefulness of previous successful work on 14 MeV neutron fission cross section measurements using this technique for a number of isotopes from ^{232}Th through ^{241}Am, a systematic study of the factors affecting the accuracy of the measurements has been made. It is shown that the results depend critically on the target thickness, uniformity, the optical magnification used for the observations of both the reference and the unknown. Optimum conditions for accurate cross section measurements are discussed in the light of these experiments. (auth)

31073 STANDARDIZATION OF RADIONUCLIDES: TECHNIQUES AND ACCURACY. McNair, A. (Radiochemical Centre, Amersham, Eng.). pp 181-7 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

An outline is given of the procedures used for standardizing radionuclides at The Radiochemical Centre. The factors that affect the accuracy of the results obtained with different techniques are discussed. (6 references). (auth)

31074 ANALYTICAL DEVELOPMENTS IN THE APPLICATION OF GAMMA RAY SPECTROMETRY TO RADIOCHEMICAL ANALYSIS. Fudge, A. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 227-33 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

Advances that have been made in the detection and measurement of γ-radiation associated with nuclear transformations are described. These have been made possible by the availability of special high-purity semiconductor materials and techniques that have enabled detectors to be made with a 20- to 50-fold improvement in energy resolution over scintillation detectors. Single crystals of high quality and ultra high purity Ge or Si are usually employed. Semiconductor detectors, however, are poorer than inorganic scintillator crystals in their photoelectric or total energy absorption properties, and Si detectors are little used for γ-ray detection because of the inefficiency of the photopeak response. Another disadvantage of these detectors is the necessity to operate them and, in the case of Ge, to store them at liquid N_2 temperatures. Work is, however, in progress to overcome these disadvantages. Details are given of experimental techniques, including detector configurations, cryostat designs, signal amplification, pulse amplitude selectors, data storage systems, and output systems; also of performance of semiconductor detectors, including energy resolution, stability, linearity and energy calibration, counting rate effects, analysis of data, peak recognition and peak area measurements. Applications discussed include radiochemical analysis of radioactive solutions, non-destructive assay of irradiated specimens, gamma spectrometric examination of radioactive gases, actinide gamma spectrometric measurements, and fission yield measurements. (7 references). (UK)

31075 GAMMA SCANNING AND ISOTOPIC COMPOSITION MEASUREMENTS APPLIED TO GAS COOLED REACTORS. Butterfield, J. M.; Davies, B. S. J. (Central Electricity Generating Board, Berkeley, Eng.). pp 265-72 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

Retrospective measurements on irradiated fuel are needed to improve the accuracy of prediction of core ratings and temperatures. Accurate knowledge of operating conditions will assist better interpretation of post-irradiation observations on fuel and other core components, leading to more realistic reactor operating limits; better design information will also be obtained for the development of replaceable core components. The emphasis is upon Advanced Gas-Cooled Reactors (A.G.R.s) but some consideration is given to the High Temperature Gas-Cooled Reactor (H.T.R.), and the situation for Magnox Reactors is briefly reviewed. A system is under development for gamma-scanning individual A.G.R. fuel pins as part of a post-irradiation examination programme. The facilities which permit largely automatic operation are briefly described, together with the necessary data processing techniques. Information obtained from these measurements will be in the form of spatial distributions of several fission products of different half-lives; a range of half-lives is required to check the predictions of rating distribution adequately when this is changing with time. Both gamma-scanning and isotopic composition measurements are discussed in terms of measurement accuracy and accuracy of basic data. (15 references). (auth)

31076 PULSE COUNTING APPARATUS FOR PARTICLE BEAM. 1. Nose, Naoki; Kodera, Kumasaburo; Makita, Tsutomu (Kyoto Univ.). Shitsuryo Bunseki; 19: No. 4, 274-83(Dec 1971). (In Japanese).

Design factors and time responses of pulse counting apparatus for particle beams including ions and fast neutral species with a windowless secondary electron multiplier are discussed. Characteristics of the pre-amplifier, main amplifier and discriminator are given. (auth) (Japan)

31077 NEUTRON DETECTOR FOR THE INVESTIGATION OF PHOTONUCLEAR REACTIONS. Sorokin, Yu. I.; Krushchev, V. A.; Yur'ev, B. A. (Moscow State Univ.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 739-41(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 75-7(May-Jun 1971).

A neutron detector for studying photoneutron cross sections is described. The neutrons are moderated in water and recorded by BF_3 counters. The vertically mounted counters are immersed directly in water. The efficiency of the detector does not depend on the neutron energy in the 0.6 to 4.6 MeV range; it is 12% when 70 SNMO-5 counters are used and approximately 26% when 50 SNMO-5A counters are used. (2 figures) (auth)

31078 AMPLIFIER AND DISCRIMINATOR FOR OPERATION WITH PROPORTIONAL SLOW-NEUTRON COUNTERS. Kotov, B. A.; Pogrebnoi, V. I. (Inst. of Semiconductors, Leningrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 779-80 (May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 110-11(May-Jun 1971).

An amplifier–discriminator system is described which is designed entirely using semiconductor devices. The input impedance of the amplifier is 100 MΩ, which is ensured by using a field-effect transistor with an insulated gate. The drift of the discrimination threshold does not exceed 30 μV/°C due to the use of an integrated differential amplifier. (2 figures) (auth)

31079 MEASUREMENT OF SMALL ION CURRENTS WITH THE AID OF PHOTOMULTIPLIERS. Werner, H. W.; de Grefte, H. A. M.; Berg, J. V. D. (Philips Research Labs., Eindhoven, Netherlands). J. Mass Spectrom. Ion Phys.; 8: No. 5, 459-74 (May 1972).

A short survey of the various methods for measuring small ion currents (10^{-9} to 10^{-20} A) is given including ion current measurement (with d.c. amplifier, vibrating-reed electrometer amplifier or multiplier), and ion counting (with open multiplier or scintillation detector). In particular, technical problems encountered in lowering the background in a Daly-type scintillation counter are discussed. In the arrangement used, the ions separated in a mass spectrometer are accelerated on to an auxiliary electrode which is at a potential of −25 kV. Opposite this auxiliary electrode (converter) is situated a scintillator. The secondary electrons released from the converter by the ions are accelerated on to the scintillator and give rise to photons which generate photoelectrons in the cathode of a photomultiplier. These photoelectrons are finally detected as a voltage pulse at the anode of the photomultiplier. The influence of the following parameters on the background of the arrangement is discussed: field emission from the converter, the absorption of cosmic radiation and radioactive radiation in the scintillator, the choice of the scintillator material, the optimum dimensions of the scintillator, thermal emission from the photocathode, and spurious effects of the electronic equipment. Methods for lowering these unwanted contributions are discussed. The lowest background obtained was 0.02 counts/sec corresponding to approximately 3×10^{-21} A. A method is described to determine the average number of electrons released at the converter per impinging active ion i.e. an ion actually releasing electrons. (auth)

31080 MEASUREMENT OF FAST- AND THERMAL-NEUTRON FLUXES USING A SMALL LiI(Eu) CRYSTAL DETECTOR. Nguyen, Dong H.; Bennett, Robert G. (Naval Postgraduate School, Monterey, Calif.). Nucl. Technol.; 14: No. 3, 284-91(Jun 1972).

A crystal detector system, composed of a small LiI(Eu) crystal, highly enriched in ^{6}Li, and a flexible light pipe, has been used to determine the fast and thermal neutron distributions resulting from a Pu–Be neutron source. The thermal neutron flux is determined by the cadmium difference technique. It is found that the thermal flux thus determined agrees well with the two-group diffusion solution and with absolute foil measurement, but gamma ray backgrounds cause serious problems in the fast flux determination by crystal. It is also found that the non-rigid light pipe offers a great deal of flexibility in the measuring process. The high efficiency in thermal neutron measurement obtained (41%) implies that smaller crystals or longer light pipes can be used, improving thereby the accessibility of the detector. The crystal detector used is also sufficiently sensitive to follow the small change in flux magnitude with increasing temperature. (auth)

31081 MEANS OF MEASURING TEMPERATURE AND NEUTRON FLUX. Gasper, Kenneth A. (to McDonnell Douglas Corp.). U. S. Patent 3,638,018. 25 Jan 1972. Filed 14 Jul 1969.

A temperature-sensing device is described including an emitter capsule containing a radioisotope fuel, a collector housing enclosing the emitter capsule, emitter capsule support means which produces a dominant thermal conduction loss in the heat balance of the device and which maintains the external emitter surface at a predetermined spacing from the internal collector surface, a cesium vapor source communicating with the interelectrode space, and emitter and collector connections providing an electrical output from the device. In this device, collector temperature is directly coupled to emitter temperature and allows determination of ambient (collector) temperature from emitter temperature which can be accurately derived from the device's output curve. A neutron-flux-sensing device is obtained by fueling the device with a material which undergoes an exothermic reaction under neutron bombardment. Heat produced is directly proportional to neutron flux present and is directly proportional to emitter temperature in a thermal conduction dominated device for a given collector temperature. Thus, the neutron flux can be determined from the emitter temperature which can be derived from the device's output curve. Alternately, in this device or a device where the thermal conduction loss is not dominant, the neutron flux can be determined from the maximum power point of the output curve. (auth)

31082 DETERMINATION OF THE SENSITIVITY OF SELF-POWERED DETECTORS IN THE THERMAL AND EPITHERMAL REGIONS OF NEUTRON FLUX. Rozenblyum, N. D.; Babuleviich, E. N.; Alekseev, A. E.; (and others). At. Energ. (USSR); 32: No. 4, 333-5(Apr 1972). (In Russian).

Self-powered detectors (SPD) with a 0.5 mm Rb wire inside a quartz cylinder (0.15 mm wall) were tested against Cd-covered Au foils, and against other SPD assemblies containing V, and Ag wires, with and without Cd filters. Experiments were conducted with such SPD assemblies at varying depths of immersion into the reactor core, from 0 to 40 cm, and comparison is made with a standard. (K.S.W.)

31083 CHARACTERIZATION OF TWO WELL-TYPE PLASTIC BETA DETECTORS WITH THIN SCINTILLATOR COATING FOR LOW BACKGROUND. Paskalev, Z. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 25-32(1967).

Well-type plastic scintillators made of Plexiglas using a scintillator of 2% p-terphenyl and 0.02% POPOP dissolved in toluene were studied. At a background of 6 pulses/min, discrimination of 9 V, and amplification 66 dB, the counting efficiency was 24% and the sensitivity was 6.7×10^{-12} Ci. (W.H.K.)

31084 PHOTOVOLTAIC EFFECT INDUCED BY X AND γ RAYS IN LIQUID-FILLED IONIZATION CHAMBERS. Jachym, A.; Jachym, B. (Danzig Technical Univ.). Acta Phys. Pol.; A41: No. 4, 471-4(Apr 1972).

During the ionization of liquid or air contained between the electrodes of an ionization chamber there is produced a potential difference of the order of one volt which causes ionization current to flow. In the case of chambers filled with liquid hexane, carbon tetrachloride and octamethyltrisiloxane the short-circuit current reached values of the order of 10^{-14} to 10^{-11} A. In air these values were of the order of saturation current of current-voltage characteristics, also of the order of 10^{-14} to 10^{-11} A. The experiment shows that the produced potential difference is induced by the bulk photovoltaic effect of the metal-dielectric-metal system and by the surface photovoltaic effect. (auth)

31085 METHOD TO PREPARE SEMICONDUCTOR SURFACE BARRIER NUCLEAR DETECTORS. Balcarcel, R.; Fernandez, A.; Gallardo, R. (Comision Nacional de Energia Nuclear, Mexico City). Rev. Mex. Fis., Supl. Fis. Apl.; 20: 55-65(1971).

Surface-barrier nuclear detectors are characterized principally by the way in which the radiation sensitive zone is achieved. N-type silicon, when exposed to the atmosphere, develops an inversion layer on the surface due to oxidation. As the oxidation occurs at room temperature, this offers a method of making a rectifier without heating the material and, therefore, without deterioration in the carrier lifetime of the silicon. This inversion layer is very thin and the junction exists close to the surface of the silicon. When a reverse bias is applied to the material, a large depletion zone is obtained. This is a suitable zone for the detection of nuclear radiation which may liberate charge carriers in a number proportional to its energy. A detailed description is made of a method to prepare the above-mentioned detectors. (auth)

31086 AUTOMATIC LIQUID SCINTILLATION COUNTING SYSTEMS. (to Nuclear-Chicago Corp.). British Patent 1,269,761. 6 Apr 1972. Priority date 8 Jan 1969, United States.

An automatic liquid scintillation counting system having an improved sample group programming apparatus is described. The counting system includes a counting station, sample transfer means, and means for counting samples in accordance with one of up to 2^n ($n > 2$) counting programs. (13 figures) (R.W.R.)

31087 APPARATUS FOR THE DETERMINATION AND AUTOMATIC TRANSFER OF POWDERS, IN PARTICULAR THERMOLUMINESCENT POWDERS. Halcewicz-Pleskaczewski, Jerzy; Janoir, Daniel; Parmentier, Nicole; Soulie, Roger (to Commissariat a l'Energie Atomique). French Patent 2,068,008. 26 Jul 1971. Filed 25 Nov 1969. (In French).

An apparatus for the determination and the transfer of powders is described. It is particularly suitable for the determination and transfer of a luminescent powder, which is to be brought to a high temperature, in order to measure the energy it has absorbed during irradiation with various radiations (α, β and γ). Lithium fluoride crystals are considered in particular. (France)

31088 COMPARISON OF THE EFFICIENCY OF DIFFERENT ISOTOPE LOCATING APPARATUSES AT THE NON-ACCUMULATING AREAS IN A PHANTOM. Altenbrunn, H.-J.; Nauber, G.; Pawlow, W.; (and others) (Deutsche Akademie der Wissenschaften, Berlin). Isotopenpraxis; 7: No. 9, 359-66(Sep 1971). (In German).

With the use of a number of the most up-to-date isotope-locating apparatuses the authors took scintigrams on a stylized liver phantom, the activity applied being of the same order as conveniently used for diagnostic examinations. Although there were no considerable differences in the perceptibility of the nonaccumulating areas, there were encountered variations in time required to obtain similarly good results. The combination of the localization apparatus with a core memory store or simply with a quantitative analyzer allowed improvement of the visibility of details. It is pointed out that a still more effective utilization of the information content, which is essentially limited by collimator parameters, will be possible by further data processing. (9 figures, 1 table) (auth)

31089 RELIABILITY AND QUEUEING THEORY: RECOVERY OF CHARACTERISTICS OF SINGLE-QUEUE SYSTEMS WITH CONSTRAINTS ON THE DURATION OF PRESENCE FROM OBSERVATIONS ON THE OUTPUT FLUX. Ivnitskii, V. A. Eng. Cybern. (USSR) (Engl. Transl.); No. 3, 52-6(May-Jun 1969).

Translated from Izv. Akad. Nauk SSSR, Tekh. Kibern.; No. 3, 52-6(May-Jun 1969).

A single-queue system with Poisson input flux with parameter λ and arbitrary distribution of service time with distribution function $H(x)$ is considered. The duration of presence in the system is bounded by a constant τ. From observations on the output stream of served and partially served demands the system characteristics λ, τ, and $H(x)$ are recovered. (auth)

31090 GEIGER-MUELLER TUBES. (to International Standard Electric Corp.). British Patent 1,269,035. 29 Mar 1972. Priority date 31 Jan 1969, France.

A Geiger-Mueller tube having several cathode cylinders of different axial cross section is described. The cylinders are arranged end to end about a common anode wire and have a common gas filling, with a gas-pervious ionization barrier between adjacent cylinders. This design has use over a larger range of exposure rates than the typical single tube. Although specifically designed as a monitor for gamma radiation, the tubes may be readily modified for use with other kinds of radiation. (3 figures) (R.W.R.)

31091 IMPROVEMENTS TO x AND γ RAY SCINTILLATORS AND TO DETECTING SCREENS UTILIZING THESE SCINTILLATORS. Driard, Bertrand; Guyot, Lucien; Roziere, Guy (to Thomson-CSF). French Patent 2,075,856. 15 Oct 1971. Filed 30 Dec 1969. (In French).

A type of x or γ ray image intensifier tube is presented. Its detecting screen consists of an activated alkali halide based layer deposited on a substrate. This luminescent layer has a fibrous structure and consists of needles which are sensibly perpendicular to the substrate. The scintillator is deposited by successive evaporations under vacuum, several layers being superposed. Before the depositing takes place an intermediate porous layer is formed on the substrate. The substrate is maintained at a temperature of less than 150°C using a cooling system. This scintillator, which is thicker than those normally obtained, adheres very well to the substrate and possesses good mechanical properties. (France)

31092 RADIATION DETECTOR. Chameroy, Jean; Laxague, Jean; Joffre, Henri; Pages, Lucien (to Commissariat a l'Energie Atomique). French Patent 2,068,732. 3 Sep 1971. Filed 27 Nov 1969. (In French).

A radiation detector is described. It presents a response to electrons, photons, and fast and thermal neutrons which approximates that of organic tissues in the energy range considered. The wall of the detector is made of a thermoplastic material: 30 to 60% by weight of polypropylene, 25 to 50% by weight of polyamide and 15 to 20% by weight of alumina or magnesia. This wall defines an enclosure containing a gaseous mixture: 10 to 80% by volume of hydrocarbons, nitrogen and at least one rare gas. (France)

31093 SCANNING APPARATUS FOR ISOTOPE DIAGNOSIS. Platz, Winfried; Kampf, Erich (to Siemens Aktiengesellschaft). U. S. Patent 3,654,465. 4 Apr 1972. Priority date 1 Jun 1968, Germany.

An apparatus for isotope diagnosis to determine the distribution of radioactive substances in a body is described. The apparatus incorporates two radiation detectors connected for synchronous scanning of an examination zone of the body, one of the detectors being mounted in an accessory which is adapted for connection to the housing of the other detector. (auth)

31094 RADIATION MEASUREMENT SYSTEM WITH MOSFET ELECTROMETER CIRCUIT WHICH IS PROTECTED AGAINST VOLTAGE TRANSIENTS. Shah, Franklin Bong-see (to Industrial Nucleonics Corp.). U. S. Patent 3,654,468. 4 Apr 1972. Filed 11 Mar 1970.

A radiation measurement system includes an electrometer circuit employing a metal-oxide-semiconductor device as an active element for amplifying a minute d.c. input signal from a radiation detector (ionization chamber) to provide an appreciable signal output voltage. The electrometer comprises means for preventing undesired voltage transients which may be applied with the input signal from puncturing the metal-oxide-semiconductor device, without impairing its ability to amplify the minute d.c. input signal. (auth)

31095 MATRIX-FORM PROPORTIONAL-MODE RADIATION DETECTOR. Kantor, Frederick W. U. S. Patent 3,654,469. 4 Apr 1972. Filed 16 May 1969.

A matrix-form radiation detector, operating in the proportional gas mode, is provided for indicating the x and y coordinates of each ionizing event caused by the radiation. This information is utilized to form an image of the radiation pattern being detected. The detector has a plurality of cathodes arranged in columns and rows. The cathodes in each column are connected to one another, and those in each row are electrically isolated from one another. A plurality of anode wires is provided. Each cathode substantially encircles one of the anode wires, and each wire passes through all of the cathodes in a given row. Encoding circuitry and other means are provided for encoding the address of each ionizing event, and for storing and/or displaying the encoded information. (auth)

31096 DISTYRYLBENZENE-DERIVATIVE SCINTILLATOR SOLUTIONS. Heller, Adam (to New England Nuclear Corp.). U. S. Patent 3,644,211. 22 Feb 1972. Priority date 27 Jun 1962, Israel.

Scintillating solutions containing as solute at least one distyrylbenzene derivative compound from the group consisting of p,p′-bis-(3,4-methylene-dioxystyryl)-benzene, 2,2′, 3,3′-tetramethoxy-distyrylbenzene, 4,4′-diisopropyl-distyryl-benzene, 2,2′-dimethoxy-distyrylbenzene, 2,2′, 5,5′-tetramethyl-distyrylbenzene, and 3,3′, 4,4′-tetramethyl-distyryl-benzene, readily soluble in organic solvents such as dioxane, xylene, and toluene, are described for use in external or internal counting of radiation. (auth)

31097 EXPERIMENTAL AND ANALYTIC STUDY OF THE RELATIONS BETWEEN THE ENERGY AND THE TRACK LENGTHS PRODUCED BY CHARGED PARTICLES IN A PLASTIC DETECTOR. Ralarosy, J.; Tripier, J.; Stein, R.; Remy, G.; Debeauvais, M. (CNRS, Strasbourg). J. Phys. (Paris); 32: No. 10, 733-42(Oct 1971). (In French).

The detection threshold and the length of the visible tracks produced by heavy ions in Makrofol were studied. The physicochemical etching conditions were maintained constant, and relations were determined between the chemical etching time and the specific critical energy loss. Empirical analytic expressions are given for the threshold and the visible range as a function of the specific energy loss of the incident ions for different etching times. (France)

31098 MEASUREMENT OF THERMAL NEUTRON FLUXES BY COMPARISON WITH THE NATIONAL PRIMARY STANDARD. Legrand, J.; Capgras, A. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 163, 49-51(Oct 1971). (In French).

The comparison of the primary standard thermal neutron flux with another flux is described. Two cases are considered: fluxes between 10^4 and $10^6 n \cdot s^{-1} cm^{-2}$ using Au detectors and high fluxes using Mn detectors. The precision obtained in both cases is presented. (France)

31099 CALIBRATION CENTER FOR IONIZING RADIATIONS. Hilaire, M. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 163, 73-7(Oct 1971). (In French).

The various facilities provided by the Ionizing Radiations Center are described. Topics include measurements of the activity of natural and artificial radionuclides in the solid, liquid, and gaseous states; quantitative and qualitative radioanalysis; direct and indirect dosimetry; and calibration of the detectors used in the metrology. The nonradioactive materials selection, and the conformity of normalized standards are also discussed. (France)

31100 STUDY OF X RAYS CARRIED OUT ON THE SATELLITE COSMOS-208. Anisimov, M. M.; Grigorov, N. L.; Illarionova, N. V.; (and others) (Moscow State Univ.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 309-11(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The design of the x-ray spectrometer installed on the satellite Cosmos-208 is described. The effective area of the proportional counters was 270 cm^2. Slot window collimators with an opening angle of 32′ × 18° (FWHM) were used. Preliminary data characterizing the operation of the instrument during flight are reported. (auth)

Radiation Dosimeters

Refer also to abstracts 31293 and 31635.

31101 (AERE-R-7040) DOSIMETRY OF KILOVOLTAGE ELECTRON BEAMS. PART I. CALORIMETRY. Hearne, J. A.; Verdin, D. (Atomic Energy Research Establishment, Harwell (England)). Mar 1972. 14p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

Aluminum and graphite calorimeters were constructed to measure the energy deposited when they pass through beams of electrons having energies in the kilovoltage region. An electrically heated aluminum calorimeter was used to demonstrate the validity of the calorimetric technique. Measurements were made of the energy deposition from the beams emitted by 200- and 300-keV electron accelerators. (UK)

31102 (CERN-71-16 (Vol. 1 and 2), pp 260-70) DOSIMETRY OF HEAVY CORPUSCULAR RADIATION (Z ≥ 2) BY MEANS OF A NUCLEAR EMULSION AND SOLID TRACK DETECTORS. Haseganu, D.; Nicolae, M. (Institutul de Fizica Atomica, Bucharest (Romania)). (In French).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1972).

The dosimetry of heavy corpuscular radiation is important in evaluating radiation risks around accelerators and in space flight. A problem in this work is that the abundance, though small, of particles having a very high LET makes the discrimination of heavy particles and hence the correct calculation of exposure difficult. Methods using nuclear emulsions and dielectric track detectors have been proposed, but they each have certain difficulties. In this work a method using both kinds of detectors together was developed; it should cover a large ionization range and eliminate, up to a point, previous difficulties. In order to diminish the fading of the latent image during exposures of long duration, an emulsion of high sensitivity is used, along with a discriminatory method of development that permits the development of all particles having a specific energy loss greater than a certain threshold. Experiments using these detectors are described. This method, which permits dividing the spectra of ions into ionization groups, covers an interval large enough for the energy spectra of ions present in primary cosmic rays. It is more sensitive than cellulose nitrate, being able to detect particles with Z = 12, while at the same time eliminating the proton background. (2 figures, 3 tables) (R.W.R.)

31103 (CERN-71-16(Vol.1 and 2), pp 271-81) USE OF SOLID VISUAL DETECTORS IN DOSIMETRY OF HIGH-ENERGY RADIATIONS. Dutrannois, J. (European Organization for Nuclear Research, Geneva (Switzerland)). (In French).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The use of solid visual detectors (in particular, Makrofol E) for the dosimetry of high-energy radiation is discussed. Plastic detectors are extremely valuable in monitoring of personnel near accelerators because of their low sensitivity to gamma rays, electrons, and protons. A response curve for this detector for alpha particles between 0.15 and 2.7 MeV is given. The development procedure always involves a previous ozonization, followed by etching. Several bases could be used; not only does the speed of the etching increase with the coefficient of dissociation, but also the number of identifiable tracks increases rapidly following the same law. The sensitivity of Makrofol E was measured, and the results are compared with other methods. (4 figures, 3 tables) (R.W.R.)

31104 (CERN-71-16(Vol.1 and 2), pp 403-14) PERSONNEL DOSE EQUIVALENT METER FOR MIXED RADIATION. Zielczynski, M.; Pszona, S. (Institute of Nuclear Research, Swierk (Poland)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The recombination method was applied in the personnel dose equivalent meter for mixed radiation. The method is based on the dependence of the ion collection efficiency on the linear energy transfer (LET) in a tissue-equivalent ionization chamber in which a columnar recombination takes place. The design and calibration of the dose equivalent meter are discussed. The accuracy of the dose equivalent determination in routine personnel dosimetry is about ± 40%. The main advantage of the three-chambered rem-meter presented is that it can be used in radiation fields with any unknown composition and spectrum. (4 figures) (R.W.R.)

31105 (CERN-71-16(Vol.1 and 2), pp 415-30) IONIZATION CHAMBER FOR THE DIRECT MEASUREMENT OF DOSE EQUIVALENT. Sullivan, A. H. (European Organization for Nuclear Research, Geneva (Switzerland)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

Problems associated with building an ionization chamber for the direct measurement of dose equivalent are first recalled. Then a chamber is described which attempts to overcome these difficulties by using a double chamber where the polarizing voltage is made to alternate between the two values required to give the correct response. The output current is then the mean of the difference current from both chambers and is independent of uniformity of radiation field and whether or not the two halves of the chamber have identical volumes. The high-voltage switch and optimization of the chamber parameters are discussed. The electrical performance, performance when measuring radiation, and effect of dose rate on the chamber with the stepped voltages are described. Direct currents of the order of 3×10^{-14} A were measurable when a 400-V step was applied to the polarizing electrodes with a frequency of about 6 Hz. The difference current can be made proportional to dose equivalent by suitable selection of gas pressure, polarizing voltages, voltage step repetition rate, and potential applied to the guard electrode. Dose rates down to 10 mrem/h could be measured. (5 figures, 2 tables) (R.W.R.)

31106 (CERN-71-16(Vol.1 and 2), pp 1035-49) RADIATION MONITORING AT NAL: INSTRUMENTS AND SYSTEMS. Awschalom, M.; Howe, H.; Schamber, F.; Shafer, R. (National Accelerator Lab., Batavia, Ill.).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The sitewide area monitoring system and special radiation survey and monitoring instruments at NAL are explained. After a general description of the instrumentation for area surveying and monitoring, the following specific instruments are considered: a gamma-compensated neutron dosimeter, a hydrogenous wall ionization chamber dosimeter, portable survey meters (gamma-sensitive neutron survey meter, gamma survey meter, and neutron, gamma, and muon survey meter), and miscellaneous instrumentation (remanent radioactivity detector and classifier; pocket-sized, audible exposure-rate warning device ("Chirper"); "Chirper" tester; radiation-activated interlock; and beam loss monitor). Finally, the radiation area monitoring system is discussed. It is built around a central data collection station and a hardwire logic system. (4 figures) (R.W.R.)

31107 (ISS-71/24) X-RAY BEAM NONUNIFORMITY EFFECTS ON DOSIMETERS CALIBRATION USING THE FREE-AIR IONIZATION CHAMBER. Pugliani, L.; Salvadori, P. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). 15 Sep 1971. 37p. (In Italian). Dep. NTIS (U. S. Sales Only).

For a proper calibration of dosimeters using the free-air ionization chamber the nonuniformity of the incident x-ray beam must be considered. Some measurements are presented leading to a satisfactory solution of the problem. (18 figures, 2 tables) (auth)

31108 DOSIMETRY IN THE FIELD OF NEUTRON AND GAMMA RAYS BY THE AID OF TLD SYSTEM. Spurny, Z. (Lab. of Radiological Dosimetry, Prague). Jad. Energ.; 18: No. 4, 126-30(Apr 1972). (In Czech).

Methods for gamma dose estimation and fast neutron dose estimation in mixed fields are discussed. A new shielding system against slow and fast neutrons for gamma dose measurements that was used during the intercomparison measurement at ORNL is described. (auth)

31109 BETA-DOSIMETRY WITH TRAPEZOIDAL SHAPED SILVER-ACTIVATED PHOSPHATE GLASS. Yokota, R.; Muto, Y.; Miyake, T. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Health Phys.; 22: No. 5, 516-19(May 1972).

Attenuation curves for two trapezoidal silver-activated phosphate glass dosimeters are presented for the following β-ray energies:- ^{90}Sr$-^{90}$Y, ^{204}Tl, ^{45}Ca, ^{14}C, and ^{63}N. The FD-T9 glass was 9.4(base) × 4.7 × 3mm and the FD-T7 was 7(base) × 3.5 × 1.5 mm. Both glasses showed linear response from 20 mrad to 1000 rads. Fading was 1.0 ± 0.2%/y in the case of glass with an absorbed dose of 5 rads. Skin dose could be measured over an average energy range from 0.06 to 1 MeV, the minimum detectable dose being 20 mrad for FD-T9-3 and 30 mrad for FD-T7-3. The energy response to x and γ rays is presented. The $\beta-\gamma$ separation was possible to within ±15% if the γ ray energy were higher than 60 keV. (UK)

31110 IRIDIUM AND TANTALUM FOILS FOR SPACEFLIGHT NEUTRON DOSIMETRY. English, Robert A.; Liles, E. Dewitt (Manned Spacecraft Center, Houston, Tex.). Health Phys.; 22: No. 5, 503-7(May 1972).

A two-foil system of iridium and tantalum was developed capable of measuring thermal and intermediate energy neutrons at flux densities of 1 n/cm^2 · sec over a 10-day lunar mission (1.0×10^6 n/cm^2). The foils were chemically inert and non-toxic, weighed less than 1 g each, and required only routine gamma pulse height analysis for activation measurement. Detection of fluences below 1.0×10^6 n/cm^2 were achieved for counts of foil activity made as late as two months following neutron exposure. Tantalum foils flown in Apollo 11 indicated a mean dose equivalent to the astronauts of less than 16 mrem from thermal plus intermediate energy neutrons, while nuclear emulsion track analysis indicated approximately 17 mrem from neutrons of energy greater than 0.6 MeV. Iridium foils flown on Apollo 12 indicated dose equivalents of 1.8 to 2.8 mrem from thermal neutrons, excluding tissue thermalized SNAP-27 neutrons. Iridium–tantalum foil pairs flown on Apollo 13 indicated a mean dose equivalent of 1.4 mrem from thermal neutrons and 0.1 mrem from intermediate energy neutrons, again excluding tissue thermalized SNAP-27 neutrons. (auth) (UK)

31111 LITHIUM FLUORIDE DOSIMETRY BASED ON RADIOPHOTOLUMINESCENCE. Regulla, Dieter F. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Munich). Health Phys.; 22: No. 5, 491-6(May 1972).

Ionizing radiation induced different absorption centers in thermoluminescent LiF. On optical excitation of the absorption bands of LiF (TLD-100) the emission of fluorescence of a characteristic spectral distribution can be observed. The intensity of the fluorescence on M-center absorption was found to be proportional to dose within a wide range. Some dosimetric properties of the radiophotoluminescence (energy dependence, sensitivity, fading) are reported and compared with those of radiothermoluminescence. (auth) (UK)

31112 CaF_2:Dy DOSIMETRY OF 80 kVp X-RAYS. Weissman, D. D.; Longhurst, G. E.; Cheng, S. C. (Univ. of California, Los Angeles). Health Phys.; 22: No. 5, 487-90(May 1972).

Response of thermoluminescent CaF_2:Dy extruded dosimeters to 80 kVp X-rays are reported. Sensitivity appeared to be 325 times greater than LiF extruded dosimeters and decreased with dosimeter thickness, decreased surface, repeated use and decreasing angles of central beam incidence. Response retention decreased after 0.5 hr post-exposure and was further depressed by fluorescent light exposure. A buildup of approximately 0.004 nC of response/day from non specific sources was monitored. (UK)

31113 USE OF CALIPLAST PVC FILMS FOR GAMMA RAY DOSIMETRY. Gupta, B. L; Bhat, R. M. (Bhabha Atomic Research Centre, Trombay, India). pp 57-62 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

The use of locally available rigid polyvinyl chloride films (Caliplast PVC) for gamma ray dosimetry in the range 5×10^4 to 5×10^6 rads has been investigated. The optimum conditions (time and temperature) for post-irradiation heat treatment in order to enhance the stability of the color produced on irradiation have been studied. For doses below 1 megarad, a film thickness of 3.5 mm has been used whereas above 1 megarad a thickness of 0.5 mm has been used. It has been observed that when 0.5 mm thick films are irradiated to high doses in the range 1 to 5 megarads there is an increase in sensitivity instead of saturation effect reported on similar films by other workers. For 0.5 mm thick films, the absorbance measurements are made at 425 nm in the dose range of 1 to 3 megarads and at 540 nm in the dose range from 3 to 5 megarads. For 3.5 mm thick films, the absorbance is measured at 425 nm in the dose range from 5×10^4 to 7×10^5 rads and at 540 nm in the dose range from 7×10^5 to 10^6 rads. (auth)

31114 DETECTION OF γ-QUANTA AND NEUTRONS BY THERMOLUMINESCENCE OF A LiF CRYSTAL. Kudelin, K. M. At. Energ. (USSR); 32: No. 4, 331-3(Apr 1972). (In Russian).

The two thermoluminescence curves characterizing the bombardment of LiF with gamma quanta or with neutrons both possess thermo peaks at 140 to 180°C (in the interval 100 to 220°C), but the 180°C peaks differ substantially in height. Ratios of the peak heights for a given type of radiation are used to determine either component in an $n + \gamma$ mixture: $I_{180^\circ}/I_{140^\circ}$ for γ quanta = 0.43, and $I_{180^\circ}/I_{140^\circ}$ for neutrons = 1.45. (K.S.W.)

31115 INVESTIGATION OF THE APPLICABILITY OF SOME PHOTOEMULSIONS TO X- AND GAMMA-RAY DOSIMETRY. Filev, G.; Vassilev, G.; Karadjov, A. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 55-62(1967).

The sensitivity and efficiency of ORWO photoemulsions with scintillating screens and lead foils were measured. Also, the effects of exposure dose rate on efficiency were studied. Results are presented graphically. (W.H.K.)

31116 HIGH SENSITIVITY DOSIMETERS FOR X AND GAMMA RADIATION. Karadjov, A.; Vassilev, G.; Filev, G. Sci. Publ, Res. Inst. Radiol. Radiat. Hyg.; 3: 63-72(1967).

The performance of Adox dosimetry film with scintillator layers for gamma and x-ray dosimetry was studied. The dependence of the density of film darkening on exposure dose, exposure dose rate, and radiation energy is presented graphically. (W.H.K.)

31117 POSSIBILITY TO IMPROVE GAMMA-RAY SENSITIVITY OF DOSIMETER PHOTOEMULSIONS. Vitev, B.; Filev, G.; Karadjov, A. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 45-53(1967).

The use of lead foils and calcium wolframate foils to improve the sensitivity of ADOX emulsions to 0.084- to 1.3-MeV gamma rays is studied. Data on the dependence of the intensification factor on gamma energy, exposure dose, and exposure dose rate are given and discussed. (W.H.K.)

31118 EQUIPMENT FOR READING RADIOTHERMOLUMINESCENT DOSIMETERS. Chenault, Roger; Prigent, Raymond (to Commissariat a l'Energie Atomique). French Patent 2,069,919. 10 Sep 1971. Filed 5 Dec 1969. (In French).

Equipment for obtaining measurements from a thermoluminescent dosimeter is presented. Essentially, it consists of: a means of heating the dosimeter in accordance with a reproducible law; a transducer sensitive to the emission of the dosimeter which converts the dosimeter output into an electric signal; an amplifier unit; and a measurement device. The equipment provides an emission spectrum, i.e., a recording of the variation in the luminous intensity as a function of time, and thus temperature. It also provides, either the integral of the emission curve as a function of time, or the peak value of the emission. (France)

31119 THERMOLUMINESCENT PROPERTIES OF $Li_2B_4O_7$:Mn IN RADIATION DOSIMETRY. Moreno y Moreno, A.; Navarrete, M.; Alva, S.; Archundia, C. (Univ. Nacional Autonoma de Mexico, Mexico City). Rev. Mex. Fis., Supl. Fis. Apl.; 20: 9-35(1971). (In Spanish).

Several methods are discussed for preparing $Li_2B_4O_7$: Mn with the purpose of selecting the optimum method according to: (a) reproducibility of glow curve with respect to the preparation methods (b) time variation of the glow curve, and (c) response of the irradiated material for different concentrations of manganese as $MnCl_2$. The material obtained shows the same spectrum response for X-ray energies from 60 to 220 keV and linear thermoluminescent behavior up to a cobalt-60/gamma exposure of 840 kR. (auth)

31120 CARD-FORMAT PERSONNEL DOSIMETER. Wheeler, Robert V. (to Technical Operations, Inc.). U. S. Patent 3,652,854. 28 Mar 1972. Filed 9 Dec 1970.

A dosimeter in the form of a laminate card is depicted. More specifically, a dosimeter card is shown which comprises a stiff but flexible backing plate having apertures for holding one or more materials sensitive to high-energy radiation. Adhesive-backed stickers carrying identification and/or instructional information are adhered back-to-back on the plate; this procedure secures the radiation-sensitive materials in their respective apertures. The plate and stickers are encapsulated between heat-bonded polyester and Mylar sheets. (2 figures) (auth)

Nuclear Spectroscopic Instrumentation

31121 (AAEC/TM-603) RADIATION SHIELDING OF AN 8 in. x 6 in. NaI(Tl) CRYSTAL FOR USE IN keV NEUTRON CAPTURE EXPERIMENTS. Broomhall, G. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nov 1971. 17p. Dep. NTIS (U. S. Sales Only).

The sensitivity of large NaI(Tl) detectors to background radiation inhibits their use in measuring partial neutron capture cross sections in the keV energy region. Major sources of neutron-induced background are the iodine in the crystal and iron in structural materials. In a survey of possible neutron shielding materials, a 70 percent by weight mixture of boron carbide in paraffin most readily reduced keV neutron fluxes. The use of a multi-layered shield assembly, incorporating an inner sleeve of boron carbide and lead shot in a litharge/glycerine cement, gave a factor of 10 improvement in the counts-to-background ratio at the 37-keV resonance in ^{48}Ti. (auth) (Australia)

31122 (ANU-P-536) COMPACT NEUTRON DETECTOR USING RESONANT SCATTERING FROM LITHIUM TO IDENTIFY LEVELS FOLLOWING NEUTRON PRODUCING REACTIONS. Bell, R. A. I.; Thompson, J. V.; Graham, I. G.; Davidson, W. F. (Australian National Univ., Canberra. Research School of Physical Sciences). [nd]. 8p. Dep. NTIS (U. S. Sales Only).

The instrument utilizes the sole sharp (Γ = 32 keV) neutron scattering resonance of ^{7}Li at 258 keV. Neutrons from a reaction are collimated on to a target of lithium metal. The scattered and transmitted fluxes are detected in highly efficient ^{3}He proportional counters surrounded by heavily shielded paraffin moderators. The ratio of these fluxes peaks sharply whenever the energy of a neutron group is on resonance, so that the excitation function of the ratio displays peaks corresponding to levels of the final nucleus. The instrument is somewhat smaller and more mobile than previously described versions. (auth) (Australia)

31123 (ANU-P-540) REPORT ON THE A.N.U. TEN INCH NaI(Tl) γ-RAY SPECTROMETER. Black, J. L.; Caelli, W. J.; Watson, R. B. (Australian National Univ., Canberra. Dept. of Nuclear Physics). Aug 1971. 79p. Dep. NTIS (U.S. Sales Only).

This report describes the NaI crystal, the phototube, the plastic scintillator, and the electronics of the Australian National University 10 × $9\frac{3}{8}$-in γ-ray spectrometer. It includes standard lineshapes measured with the spectrometer, a table of the measured energy resolution and a graph of the peak-to-total ratio as a function of γ-ray energy for three different collimation geometries. Also included are the measured cosmic-ray rejection efficiency and graphs of the calculated absolute detection efficiency and angular correlation attenuation factors. (41 figures, 8 tables) (auth) (Australia)

31124 (I.R.I.-133-70-4) ICPEAX: COMPUTER PROGRAM FOR THE AUTOMATIC ANALYSIS OF GAMMA RAY SPECTRA OBTAINED WITH HIGH RESOLUTION SEMICONDUCTOR DETECTORS. Korthoven, P. J. M. (Interuniversitair Reactor Instituut, Delft (Netherlands)). [nd]. 41p. Dep. NTIS (U. S. Sales Only).

ICPEAX is a computer program in FORTRAN IV for a PDP-9 computer for the automatic analysis of gamma-ray spectra obtained with high resolution semiconductor detectors. The peaks are located by inspection of the smoothed second and third derivatives of the spectrum. The smoothing depends on the average peak width. A region of the peak is then fitted with a Gaussian function with a non-linear least squares method. The limits of this region are determined by the quality of the detector response. From the peak parameters the area and energy of all peaks are calculated. Error estimates for these quantities are also given. (auth)

31125 (JINR-13-6292) Ge(Li) DETECTOR WITH HIGH RESOLUTION. Ukhrin, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

A high-resolution Ge detector was made by the method of Li ion drift for use in the measurement of low- and medium-energy gamma rays. The resolving power was 1.1 keV for the 121.9-keV ^{57}Co gamma ray; it is thus practicable to measure the lifetimes of excited nuclear levels in heavy atoms by the Doppler effect. (4 figures) (tr-auth)

31126 (JINR-P6-6229) APPARATUS FOR RECOIL-DISTANCE LIFETIME MEASUREMENTS. Bochev, B.; Karamian, S. A.; Kutsarova, T.; Nadjakov, E.; Subbotin, V. G.; Uchrin, J.; Chugreev, V. A. (Joint Inst. for Nuclear Research Dubna (USSR). Lab. of Nuclear Reactions). 1972. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

Apparatus for recoil-distance measurements of nuclear lifetimes is described. Lifetimes of rotational levels of ^{160}Er, produced in the reaction ^{124}Sn(^{40}Ar, 4n), were measured in order to check the technique. Good agreement with the data published was obtained. (3 figures, 1 table) (auth)

31127 (JINR-P13-6261) TELESCOPE FOR RECORDING SMALL ENERGY PROTONS ON THE INTENSE BETA BACKGROUND. Bogdanov, D. D.; Karnaukhov, V. A.; Petrov, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

A telescope is described which consists of two plane proportional counters and a semiconductor detector. The telescope is intended for low-energy (0.5 to 6.0 MeV) proton spectrometry in the presence of an intense background of β and γ radiation. Use of the proportional counters in the controlling coincidence channel reduces considerably the $\beta-\gamma$ background of the semiconductor detector in comparison with the case when only one counter is used. (3 figures) (auth)

31128 (UJV-2720-F) DETECTION EFFICIENCY FOR NEUTRON-CAPTURE GAMMA RAYS OF A ^{10}B DETECTOR DETERMINED BY THE MONTE CARLO METHOD. Bayer, R. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Jan 1972. 33p. (In French). Dep. NTIS (U. S. Sales Only).

For measurements of neutron spectra by the time-of-flight method, calculations and analysis of the detection efficiency of the capture gamma rays in a system consisting of a central detector surrounded by four NaI(Tl) crystals were carried out. The central detector of cylindrical shape contained a homogeneous mixture of ^{10}B with polyethylene of different thicknesses and/or a 1.5-cm layer of boric carbide. The gamma-ray detection probabilities as a function of the position of neutron capture were calculated by the Monte Carlo method. (31 figures, 3 tables) (auth)

31129 APPLICATION OF n-i-p TYPE SEMICONDUCTORS IN MULTICOMPONENT RADIOMETRIC X RAY ANALYSIS. Yakubovich, A. L.; Przhiyalgovskii, S. M.; Tsameryan, G. N. At. Energ. (USSR); 32: No. 3, 241-3(Mar 1972). (In Russian).

In tests with a Si(Li) detector cooled in liquid nitrogen, ^{55}Fe, ^{119m}Sn, ^{241}Am, and ^{238}Pu were used as radiation sources and a variety of elements were determined. For each element the threshold of response, line contrast, and statistical error were tabulated. Use of such a detector appears promising for radiometric x-ray analysis of elements with characteristic radiation energy in the range 2.5 to 30 keV. (K.S.W.)

31130 ELONGATED CRYSTALS IN SCINTILLATION COUNTERS. Novikov, G. F.; Sinitsyn, A. Ya.; Kozynda, Yu. O.; Vyshenkov, V. V. At. Energ. (USSR); 32: No. 3, 238-40(Mar 1972). (In Russian).

Crystals of NaI(Tl) and CsI(Tl) of various lengths were used to measure the γ spectra of masses of U and Th, and the inherent errors in assaying U and Th in ores in situ were evaluated. The maximum ratio of crystal length to diameter was six. The specific count rates for crystals of length 20, 40, 70, and 140 mm were determined for U, Th, and K. (K.S.W.)

31131 HIGH-RESOLUTION ELECTROSTATIC SPECTROMETER FOR THE SIEGBAHN ESCA METHOD. Yavor, S. Ya.; Petrov, I. A.; Denisov, E. P. (Ioffe Inst. of Physics and Tech., Leningrad. Leningrad State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1455-60(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1839-44(Sep 1971).

A new electron spectrometer is described with a dispersive element consisting of two pairs of immersion cylindrical lenses with matched center planes. The focusing elements are doublets consisting of five-electrode quadrupole-octupole lenses. The instrument parameters are given and typical spectra for photoelectrons and Auger electrons are presented. (auth)

31132 HIGH-RESOLUTION GAMMA-RAY SPECTROMETRY FOR NUCLEAR TECHNOLOGY. Kristak, Jozef; Vobecky, Miloslav (Inst. of Nuclear Research, Rez, Czech). Jad. Energ.; 18: No. 4, 117-26(Apr 1972).

Some possibilities of using semiconductor Ge(Li) detectors of gamma radiation in reactor technology are discussed with emphasis on the nondestructive determination of the fuel element burnup. Some experimental results on the burn-up determination of model specimens are presented. In the Addendum are tabulated current data on the intensities and energies of gamma transitions of calibration sources as well as the most important radioactive fission products and some products of activation of technological materials and mediums. (auth)

31133 LOW-LEVEL CHEMICAL DOSIMETRIC SYSTEM. Gupta, B. L. (Bhabha Atomic Research Centre, Trombay, India). pp 49-55 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.2).

An aqueous aerated dosimetric system containing ferrous sulphate, xylenol orange and benzoic acid in 0.05 N H_2SO_4 has been developed to measure gamma doses from 1 to 2000 rads. Using a 4 cm. cell and a spectrophotometer with a sensitivity of 0.005, doses in the range of 5 to 2000 rads have been successfully measured. It is expected that by using a 10 cm. cell and a spectrophotometer having a sensitivity of 0.001, the minimum dose measurable can be brought down to 1 rad. This dosimeter is found to be independent of dose rate in the range 16 to 230 rads/min. It is further found that this dosimeter is independent of initial concentrations of the various constituents—a variation of as much as 100% around the recommended values of concentrations does not lead to any noticeable error in dose determinations. The accuracy of the system is found to be better than ±2% above 25 rads. While measurements have yet to be made to establish the accuracies below this value, it is anticipated that this will be governed by the sensitivity of the spectrophotometer used for the measurements. (auth)

31134 PROBLEMS AND IMPROVEMENTS IN LOW GEOMETRY ALPHA COUNTING. Spernol, A.; Denecke, B. (Bureau for Nuclear Measurements, Geel, Belgium). pp 199-203 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

The problems and recent improvements in defined-solid-angle low-geometry alpha counting are discussed. It is shown that the method should yield accuracies of about ±0.02%. (35 references). (auth)

31135 ALPHA SPECTRA AND ASSOCIATED TECHNIQUES AND MEASUREMENTS. Glover, K. M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 205-13 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

Alpha spectrometry is the technique most widely used in the analytical control of chemical separations of the actinide elements. It is also used in transmutation experiments where the α-particle energy and half-life of new nuclei are required. A number of other applications are also mentioned. Choice of detector is discussed, and a description given of the gridded ion chamber and the surface barrier detector chamber. Information is given on source preparation and experimental procedure. (5 references). (UK)

31136 SPECTROMETER FOR A PULSED ELECTRON BEAM. Gerasimov, A. I.; Dubinov, E. G.; Kudasov, B. G. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 688-91(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 31-4(May-Jun 1971).

A magnetic spectrometer is described which allows the maximum energy to be measured with an accuracy of 2.5% and the energy spectrum of the beam to be recorded with an error not exceeding 10% after one-shot operation (one pulse or a train of pulses) of a source of accelerated electrons. The magnet construction, the schematic of the electrometer amplifier, and their characteristics are given, as well as the experimental results of determining the beam parameters for a current-pulse length of 0.03 to 0.5 μsec for maximum electron-beam energy of about 1 MeV. The factors which affect the accuracy of the measurements are indicated. (4 figures) (auth)

31137 SCINTILLATION ASSEMBLIES FOR THE DETECTION OF LONGWAVE X RADIATION. Al'perovich, V. R.; Grinberg, N. B.; Kozlov, A. V.; Komyak, N. I. (Central Design Bureau of X-Ray Equipment, Leningrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 893-5(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 202-4(May-Jun 1971).

Scintillation detection assemblies of the EPS-1 and EPS-2 types having class one accuracy are described. For Cu K_α (8.05 keV) x radiation the blocks have the following basic characteristics: intrinsic background 10 pulses/min, amplitude resolution ≤50%, output-signal amplitude 50 to 500 mV. (4 figures) (auth)

31138 TIME-OF-FLIGHT SPECTROMETER FOR FAST NEUTRONS. Biryukov, N. S.; Zhuravlev, B. V.; Kornilov, N. V.; (and others) (Inst. of Physics and Power, Obninsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 729-32 (May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 66-9(May-Jun 1971).

A time-of-flight neutron spectrometer which is used to measure the spectra of scattered neutrons having an initial energy ~10 MeV on the 150-cm cyclotron of the Physics and Power Institute is described. The resolving power of the spectrometer, as determined from the γ peak, is 2.3 ns/m. The channel width is 1.28 ns. The integral nonlinearity is 0.25%, while the differential nonlinearity is 2%. In order to illustrate the operation of the spectrometer, the spectrum of neutrons from ^{238}U is presented. (3 figures) (auth)

31139 USE OF FIELD-EFFECT TRANSISTORS IN SPECTROMETRIC AMPLIFIERS. Ponomarev, V. S.; Zhukovskii, A. N. (Central Design Bureau of X-Ray Equipment, Leningrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 781-3 (May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 111-14(May-Jun 1971).

Results are given of investigations of Soviet field-effect transistors in the circuits of low-noise spectrometric amplifiers for semiconductor detectors. The temperature dependence of the transconductance and gate currents of the field-effect transistors in the 77 to 300°K range was investigated. With the use of a germanium radiation detector and the low-noise amplifier developed by the authors, the energy resolution of the system for the Ag K_α line was 760 eV. (3 figures, 2 tables) (auth)

31140 USE OF MULTIPLE-TAPE SOURCES IN HIGH-RESOLUTION BETA SPECTROMETERS. Kalinauskas, R. A.; Makaryunas, K. V.; Davidonis, R. I. (Inst. of Physics and Mathematics, Vilnyus, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 717-18(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 57(May-Jun 1971).

In measurements of the spectra of internal conversion electrons using a prism β spectrometer of the UMB-1 type with multitape sources a resolution $\Delta p/p = 0.03\%$ was achieved with respect to the electron momenta. The possibility of improving the resolution to 0.015 to 0.02% is indicated. (1 figure) (auth)

31141 USING THE MONTE CARLO METHOD TO CALCULATE THE CHARACTERISTICS OF A SCINTILLATION GAMMA SPECTROMETER IN A RING GEOMETRY. Kortyn, L. D.; Pozdneev, D. B.; Trunov, N. N. (Gorky State Univ., USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 719-21 (May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 58-60(May-Jun 1971).

The Monte Carlo method was used to calculate the equipment spectra, the values of efficiency, the photopeak, and the photoefficiency of a scintillation γ spectrometer with a crystal 40 mm in diameter and 40 mm high which records γ quanta from a ring radiating iron sample (primary-photon energy $E_0 = 0.845$ MeV) on an M-20 computer. (4 figures) (auth)

31142 THRESHOLD DEVICE FOR PULSE SHAPING. Sinitsyn, A. Ya. (Leningrad Mining Inst.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 766-7(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 100-2(May-Jun 1971).

A circuit is described which allows pulses having a small amplitude which do not carry useful information to be eliminated from the spectrum arriving from the detector in order to reduce the quantity of transmitted and analyzed pulse information without shifting the zero of the spectrometer energy scale or distorting the amplitude distribution. The process is accompanied by the formation of a flat top of the pulses. (2 figures) (auth)

31143 OPERATION START OF THE AUTOMATED LEAD SPECTROMETER INSTALLATION WITH FIRST EXPERIMENTAL RESULTS. Krinninger, H.; Ruppert, E. (INTERATOM, Bensberg, Ger.). Atomwirt., Atomtech.; 17: No. 5, 267-8(May 1972). (In German).

Following completion, the automated lead spectrometer installation for fission material flux control began operation. A continuous 3-month trial demonstrated both readiness for operation and meeting of specifications. In addition to start-up several other problems were studied such as operational safety of components, verification of reliability through theoretical examinations, self-shielding in uranium–plutonium fuel rods, and stability and sensitivity of the measuring system. (tr-auth)

31144 DEVICE FOR LIQUID SCINTILLATION SPECTROMETRY. Rosenstingl, Emmanuel (to Intertechnique SA). French Patent 2,067,931. 26 Jul 1971. Filed 21 Nov 1969. (In French).

A device for automatically correcting liquid scintillation spectrometry measurements in such a way as to reduce errors due to the inhibition of the scintillation process (chemical or color weakening) is described. This method provides a high precision without count losses, and can be fully automated. (France)

31145 GAMMA RAY DETECTORS BASED ON i-CONDUCTION GERMANIUM. Vavilov, V. S.; Goncharov, L. A.; Pavlova, T. I.; Ukhrin, Ya.; Chukichev, M. V. At. Energ. (USSR); 32: No. 4, 335-6(Apr 1972). (In Russian).

A new stage in the development of the semiconductor spectrometry of γ quanta is the production of high-purity Ge detectors which the author proposes to call "i-germanium" gamma detectors. The preparation of a detector is described and its capacitance is graphed. The admissible homogeneity of the original material for fabrication of spectrometric detectors may be achieved even at significant levels of compensation, and consequently, with a decrease in the total impurity concentration the spectrometric properties of the detectors may be improved. Strongly compensated material may be used for preparing detectors for certain physical problems. (K.S.W.)

31146 GERMANIUM RADIATION COUNTERS AS SPECTROMETERS FOR CHARGED PARTICLES. Ryvkin, S. M.; Peller, V. V.; Strokan, N. B.; (and others). At. Energ. (USSR); 32: No. 4, 336-8 (Apr 1972). (In Russian).

Germanium radiation counters were used to determine the energy of charged particles. Their resolution capability depends on the donor impurity concentration in the original germanium. Counters were prepared from Ge with an impurity concentration of 5×10^{12} cm^{-3}, and having an orientation of either [111] or [100]. The detectors were assembled in ampules and irradiated with α particles from ^{238}Pu or electrons from ^{207}Bi. Results with α and β particles were high, and the counter resolved γ quanta from ^{137}Cs to 1%. (K.S.W.)

31147 NaI(Tl) SHIELDED Ge(Li) DETECTOR SYSTEM FOR ACTIVATION ANALYSIS AND ITS APPLICATION TO GEOLOGICAL MATERIAL. Currie, Richard Lynn. Ithaca, N. Y.; Cornell Univ. (1971). 121p. University Microfilms Order No. 72-13,151.

Thesis.

An eight inch diameter by ten inch long NaI(Tl) annulus with a three inch diameter central tunnel has been used as a secondary photon detector with a 30 cc, coaxially drifted Ge(Li) gamma ray detector to form a coincidence-anticoincidence spectrometer for use in activation analysis. The system employs intimate source-detector geometry, but avoids reduction in the photopeak intensity of gamma peaks from cascade members through use of a routing scheme. This information storage technique accepts all energy pulses from the Ge(Li) detector and routes them to preselected memory sections depending on the nature of their coincidence condition. A detailed theoretical investigation of the factors which affect the statistics of activation analysis results is performed which quantitatively reveals the utility of such a spectrometer system for certain spectra. In particular, a comparison of the improved spectrum to that obtained from the Ge(Li) detector alone and to that obtained from repeated activation and counting cycles is made and the results used to determine the original peak-to-background ratio below which the system becomes useful or necessary. In addition, such considerations as the secondary Compton angular distribution, count rate capabilities of NaI(Tl) and plastic scintillators, electromagnetic radiation interaction cross-sections, Ge(Li) detector resolution and efficiency, and coincidence resolving time are discussed as they have affected the choice of detector geometry, cryostat design, and electronic configuration of the final system. The system's performance is evaluated through use of a series of varying intensity Zn^{65} sources. A rate-dependent, energy-independent decrease in suppression is found and shown to be due to a rate-dependent failure to detect actual coincidences, probably due to some logic element's duty cycle limitation. The reduction in effective Ge(Li) photoefficiency due to chance coincidences is less than 1% at 5.7×10^4 dps and is shown to follow the expected rate-squared dependence. To demonstrate the usefulness of the system in practical activation analysis problems, it is applied to the chemically separated fractions resulting from a rapid group-separation scheme routinely used on geological materials at Cornell. The expected improvement in statistical error for small peaks is observed and one case in which an element is not quantitatively detectable without suppression is reported. In addition, two cases are observed in which peaks thought to be due to single transitions were found to contain additional events due to cascade gammas, causing the corresponding reported elemental abundances to be lowered by about 10%. (Diss. Abstr. Int., B)

High Energy Physics Instrumentation

Refer also to abstract 32593.

31148 (BNL–16689) DATA PROCESSING FOR ELECTRONIC TECHNIQUES IN HIGH ENERGY EXPERIMENTS. Lindenbaum,

S. J. (Brookhaven National Lab., Upton, N. Y. City Coll., New York. Dept. of Physics). [1971]. 56p. Dep. NTIS.

A review of the historical development of computer techniques in high-energy physics research is given, and various operating computer systems for high-energy research are described. (W.H.K.)

31149 (INR–1373) DEVICE FOR SEMIAUTOMATIC GEOMETRY MEASUREMENTS OF NUCLEAR INTERACTION EVENTS REGISTERED ON THE BUBBLE CHAMBER PICTURES. Michalski, Mieczyslaw; Pluta, Jan; Poniatowski, Marek; Slowinski, Bronislaw; Starzynski, Andrzej; Strugalski, Zbigniew (Institute of Nuclear Research, Warsaw (Poland)). 1972. 20p. (In Polish). Dep. NTIS (U. S. Sales Only).

A short description of a device for semiautomatic surveying of the geometry of nuclear interaction events detected in a xenon bubble chamber is given. The basic operational characteristics of this device are reported. The semiautomatic device can also be used to survey the pictures from other detectors, e.g., hydrogen or propane bubble chambers, spark chambers, streamer chambers, etc. (4 figures, 2 tables) (auth)

31150 (LUSY–7102) ON-LINE COUNTER HODOSCOPE FOR HIGH-ENERGY PHOTOPROTONS. Dougan, P.; Kivikas, T.; Lugner, K.; Ramsay, V.; Stiefler, W. (Lund Univ. (Sweden). Dept. of Physics). Nov 1971. 29p. Dep. NTIS (U. S. Sales Only).

The design and performance of an on-line counter hodoscope for the study of high-energy protons from photon-induced reactions are discussed. (auth)

31151 (RHEL/R–235) COMPUTER PROGRAM FOR MATCHING TRACK IMAGES FROM THREE VIEWS IN A BUBBLE CHAMBER. Bryden, A. D. (Rutherford High Energy Lab., Chilton (England)). Jan 1972. 35p. Dep. NTIS (U. S. Sales Only). UK 40 pence.

A program was developed from the Rutherford Laboratory Geometry Program to match different views of tracks in film from a conventional bubble chamber. This is part of the chain of programs for processing data from HPD in the Road Guidance mode, and to date about 500,000 events have been processed through it. Extension to deal with events digitized using Minimum Guidance is discussed. (auth) (UK)

31152 CALIBRATION AND USE OF PLASTIC TRACK DETECTORS IN THE STUDY OF EXTREMELY HEAVY COSMIC RAYS. Blanford, George Emmanuel Jr. St. Louis; Washington Univ. (1971). 205p. University Microfilms Order No. 72-9319 Thesis.

Different types of plastic track detectors were used in five high altitude balloon flights to collect extremely heavy cosmic rays. The detectors were flown from Palestine, Texas where their flight paths were characterized by an average vertical cut-off rigidity of 4.6 GeV. In a total exposure of 1.4×10^7 m^2 sr sec, 546 altitude events were observed. Two additional balloon flights were made at low geomagnetic cut-offs to collect stopping cosmic rays to calibrate the response of plastics to ionizing particles. Calibrations were also done using accelerated heavy ions. It was found that the track etching rate V_t for high energy particles is consistent with a power function $V_t = A\ J^m$ of the ionization J. The ionization J is given by the expression $J = C_1\ (Z^{*2}/\beta^2)\ [\ln(\beta^2/1 - \beta^2) - \beta^2 + C_3]$ where Z^* is the effective charge of the particle, β is the ratio of the particle velocity to the velocity of light and C_3 is a term that is determined empirically. It is found that $C_3 = 30 \pm ^{35}_{15}$ for Lexan, and $C_3 = 16.2 \pm ^{8}_{4}$ for two different cellulose plastics. The ionization equation and the response function were used to determine the atomic number of 256 altitude events. These events were divided into several groups and the cosmic ray fluxes were found. The relationship of these values to present theories of cosmic ray origin is discussed. An additional 88 altitude tracks were unexpectedly found to slow down or stop in the detectors. The origin of these particles is unknown. (Diss. Abstr. Int., B)

31153 STUDY OF NOISE ELIMINATION IN RELATIVE SCATTERING MEASUREMENT. Teranaka, Masahiko (Osaka City Univ.); Wada, Tomonori; Konishi, Sachiko; Kusumoto, Osamu; Konishi, Takeharu. J. Phys. Soc. Jap.; 32: No. 4, 899-903(Apr 1972).

Characters of the noise associated with relative scattering measurement in nuclear emulsions are studied as functions of cell size and of track separation in depth of emulsion for three stacks having independent histories. It is found that the noise is divided into two characteristic types according to cell size. For short cell size, the noise is a random Gaussian type and for long cell size of more than about 3 mm, essentially, ordinary C or S shape. Although the track to track separation in depth is usually limited severely in relative scattering, it is shown that this limitation can be removed by cancelling the noise in such a way that for short cell size the subtraction method is applied between the second and third order differences and for long cell size the ordinary higher order difference method is applied. This increases greatly the applicability of the relative scattering method. (auth)

31154 DETERMINATION OF THE ENERGY SPECTRUM OF COSMIC PARTICLES. Gal'per, A. M.; Kurochkin, A. V.; Luchkov, B. I.; Yurkin, Yu. T. (Moscow Engineering-Physics Inst.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 722–4 (May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 60-2(May-Jun 1971).

A method of determining the differential energy spectrum of cosmic particles in instruments having a poor resolution is described; the method is based on solving an integral Fredholm equation of the first kind by means of the regularization algorithm. The method is applied to an instrument designed for investigating cosmic electrons and high-energy γ quanta. The results of simulating the physical experiments are presented for the purpose of explaining the spectrometric capabilities of the instrument. The statistical errors in the spectrum are calculated by the Monte Carlo method. (3 figures) (auth)

31155 DETECTOR FOR MEASURING THE ENERGY OF ULTRARELATIVISTIC PARTICLES. Lorikyan, M. P. (Inst. of Physics, Erevan). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 737-8(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 73–4(May-Jun 1971).

A new detector for the identification of ultrahigh-energy particles from transition radiation in the x-ray frequency range is described. (1 figure) (auth)

31156 EFFECT OF A MAGNETIC FIELD ON THE LOCALIZATION OF TRACKS IN A SPARK CHAMBER. Bostandzhyan, N. Kh.; Marikyan, G. A.; Matevosyan, K. A. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 742-4(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 78-80(May-Jun 1971).

The characteristics of tracks in spark chambers in a magnetic field and without a magnetic field were investigated for various values of the time delay of the triggering pulse of the chambers (2 to 22 μs). It turned out that the magnetic field increases the upper boundary of the measurable densities of shower particles and reduces the mean-square value of the deviation of the extreme points of the track from the particle trajectory. (2 figures, 2 tables) (auth)

31157 HIGH-SPEED HIGH-PRESSURE VALVE FOR A BUBBLE CHAMBER. Balandin, M. P.; Granichev, V. I.; Moiseenko, V. A.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 745-7(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 80-3(May-Jun 1971).

A high-speed slide valve operating at a pressure of 1 atm with a flow cross section of 20 cm^2 is described. The piston in the valve is braked by means of an air damper. In order to set the operating mode for impact-free stopping of the piston, the valve is equipped with piezoelectric pressure pickups. The time required for the pressure valve to open at a controlling pressure of 5 atm is 5 ms. After 5×10^5 cycles the seals still remained hermetic. (3 figures) (auth)

31158 MODELS OF TRACK CREATION OF CHARGED PARTICLES TRANSVERSING DIELECTRIC DETECTORS. Linscheid, Anna (Katedra Fizyki Wyzszej Szkoly Rolniczej, Krakow). Postepy Fiz.; 22: No. 5, 511-20(1971). (In Polish).

The described models are the attempt at understanding the mechanism of creating tracks by massive charged particles in dielectric detectors. Fleisher and Price state that the massive charged particle passing through an insulating material causes a region of damage to occur. Their "ion explosion spike" model assumes that in this region the positively charged ions eject themselves into the surrounding lattice by mutual repulsion. Katz and Kobetich draw our attention to the fact that the mechanism of track creation can be different at different energies of the registered particle. At energies ~0.05 MeV/amu the author suggests that the track results from the interaction of δ-rays with the molecules of the medium. This picture justifies the fact that there exists a critical rate of energy loss $(dE/dx)_{cr}$ such that particles losing at least this value produce continuous tracks. (auth)

31159 RELATIVISTIC INCREASE OF AN IONIZATION IN GAS TRACK DETECTORS. Merzon, G. I. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 15: No. 2, 278-83(Feb 1972). (In Russian).

The inaccuracy of the Sternheimer formula for the specific energy loss of fast charged particles was shown for measured ionization results in cloud chambers and other track detectors containing gases of average and large atomic number. Modification of this formula permits agreement between the theory and experimental data obtained by Kepler et al. for argon, helium–argon, and helium–xenon mixtures. The results of this work must be taken into account in planning experiments where the identification of 100-GeV particles is made by using the relativistic increase of the ionization in the gas. (2 figures, 1 table) (auth)

Radiometric Instruments

31160 (EGG–1183–1495) WATER EQUIVALENT OF SNOW SURVEYS USING NATURAL TERRAIN RADIATION. Technical Report No. L–1013. Fritzsche, A. E.; Burson, Z. G. (EG and G, Inc., Las Vegas, Nev.). 23 Nov 1970. 112p. Dep. NTIS.

The feasibility of measuring water equivalent of snow cover by detection of natural terrain radiation was investigated. Multiple arrays of NaI crystals were used in the Aerial Radiological Measuring Surveys (ARMS) system for the airborne measurements. A single 4 × 4 inch NaI crystal in a portable unit was used for ground surveys. Equivalent water of the snow cover was measured by the snow tube technique. The accuracy of predicting the equivalent water in snow from the ARMS aircraft varied from 17 to 30% for deep to shallow snow, respectively. The accuracy on the ground (utilizing the portable unit) was much the same, although less data were available. Both air and ground surveys of natural terrain radiation, as a means of determining equivalent water of snow cover show much promise. The accumulation of more data and further analysis are necessary to decrease the uncertainties of this technique. (auth)

31161 MOISTURE CONTENT AND DENSITY MEASUREMENT: PRECISION OF THE RADIOMETRIC METHOD. Novakova, O.; Slezak, V. (Vyzkumny Ustav Pristroju Jaderne Techniky, Premysleni, Czech). Radioisotopy; 13: No. 2, 381-98(1972). (In Czech).

The technique of volume humidity and density measurements in low-depth as well as in deep-hole measurements is described. The method employs a gamma and neutron scintillation detector. (auth)

31162 SOME ASPECTS OF A GAMMA-RAY BACK SCATTER THICKNESS GAUGE. Musilek, L. (Vyzkumny Ustav Pristroju Jaderne Techniky, Premysleni, Czech). Radioisotopy; 13: No. 2, 399-414(1972). (In Czech).

The construction problems of a gamma-ray backscatter thickness gauge, used for wall thickness measurements of tanks, pipes and other devices accessible only from one side are discussed. (auth)

31163 AUTOMATIC CONTROL OF COKE DOSING IN THE PRODUCTION OF LUMP LIME BY MEANS OF THE NEUTRON MOISTURE GAUGE G 140. Votava, P. (Vyzkumny Ustav Stavebnich Hmot, Brno). Radioisotopy; 13: No. 2, 423-32(1972). (In Czech).

A method of automatic control of coke dosing in the production of lump lime by calcination of limestone using the neutron moisture gauge G 140 is described, and the economical advantages of the method are evaluated. (auth)

31164 IN-LINE PROCESS CONTROL FOR WIRE THICKNESS MEASUREMENTS BY MEANS OF RADIOISOTOPES. Plesch, R. (Siemens AG, Karlsruhe, Ger.). Siemens-Z.; 45: No. 10, 652-4(1971). (In German).

The principle of the method, the measuring head (NaI-Tl detector) and the readout electronics are described for a ^{241}Am gage. It is employed for the thickness measurement of smooth and ribbed wires of steel (0.1–30 mm), copper (0.1–30 mm) and aluminum (0.3–30 mm). For thinner wires, ^{238}Pu is used. Economic considerations show a material savings of 9%. (INIS)

31165 RADIOMETRIC DUST MEASURING UNIT. Krohne, L. Umwelt; 1: No. 5, 59(Oct-Nov 1971). (In German).

For radiometric dust measurement, a defined gas sample is drawn off from the main gas flow and passed over a glass fiber filter. The dust retained in the filter is measured by determination of the radiation absorption of the radioactive isotope carbon (14). This radiometric mass determination, which is independent of the type of dust and the grain size, is equivalent to the gravimetric measurement. The dust concentration is recorded in mg/cu m. The measurement range can be selected from 0 to 10 mg/cu m to 0-1000 mg/cu m. The tolerance is plus or minus 10%. The dust measuring unit is most suitable for controlling the efficiency of dust collectors and filters with high accuracy as it is required in the metallurgical industry, the cement industry, in incinerators, in the chemical industry, and in power plants. (Air Pollut. Abstr.)

31166 EXPERIENCE WITH THE RADIOMETRIC DUST GAGE BETA-DUST METER. Dresia, H. (Staatliche Ingenieurschule fuer Maschinenwesen, Essen); Spohr, F. Staub; 31: No. 6, 243-9(1971). (In German).

Using the beta-dust meter (^{14}C gage) extensive operational experience during employment in coal-fired power plants, iron and steel works, and in cement and chemical industry has been gained. The universal applicability of this gage which is based on the attenuation of β-particles in the dust deposition of a fiber filter could be confirmed. A good measuring precision can be obtained by direct linear recording of the concentration in mg/Nm^3. The swinging gas-sampling probe periodically sweeps the cross section of the main gas current for emission measurements. Because of its simple calibration there is no need for gravimetric comparison measuring. (INIS)

31167 CALIBRATION OF GAMMA–GAMMA DENSITOMETERS USING RADIATION SOURCES OF VARIOUS ENERGIES. Umiastowski, K. At. Energ. (USSR); 32: No. 293-6(Apr 1972). (In Russian).

Calibration curves were calculated for aluminum and water using fundamental formulas, and then were compared with experimental data. Satisfactory agreement was observed. It was noted that when a wide range of radiation energy was used (^{75}Se ~ 200 keV to ^{60}Co = 1.33 MeV), the calibration accuracy was distinctly raised, and calibration curves could be constructed for a wider range of density. (K.S.W.)

31168 DEVELOPMENT OF AN AUTOMATED LEAD-SPECTROMETER ARRANGEMENT AS EQUIPMENT FOR CONTROL OF FISSIONABLE MATERIAL FLOW (ABSA). Krinninger, H.; Ruppert, E. (INTERATOM, Bensberg, Ger.). Atomwirt., Atomtech.; 17: No. 4, 199-200(Apr 1972). (In German).

The ABSA equipment is intended for use in fuel rod production. The following specifications are met: the measuring procedure is not coupled to the production process; installation and removal of equipment components require no lifting machinery; the measuring room is accessible during operation; reverse transport permits automatic repetition of measurements on suspicious fuel rods; data are automatically collected, evaluated, and recorded; the measuring process is computer-controlled; automatic cyclic monitoring is performed; and tested fuel rods are automatically marked for identification. The ABSA installation essentially comprises the following components: lead pile with shielding; neutron generator; installation for exchange and storage of fuel rods; and analog electronics with process computer system. (3 figures) (H.B.G.)

Radiation Effects on Instrument Components, Instruments, and Electronic Systems

Refer also to abstract 32664.

31169 (UCRL–73654) ACCELEROMETERS FOR THE MISTY NORTH EVENT. Freynik, Henry (California Univ., Livermore. Lawrence Livermore Lab.). 5 Apr 1972. 9p. (CONF–720312–8). Dep. NTIS.

From Underground nuclear test measurement symposium II; Menlo Park, CA. (21 Mar 1972).

The design philosophy and the laboratory experiments to qualify accelerometers for the Misty North event are discussed. The principal difficulty is the necessity to measure low frequency, low amplitude accelerations in the presence of high frequency shocks. In past experiments high frequency shocks have too often excited ringing in the accelerometers. Most accelerometers were radiation-hardened Endevco 2264/2266 piezoresistive accelerometers. (auth)

31170 EFFECTS OF IONIZING RADIATION IN MIS DEVICES: A REVIEW. Zaininger, K. H. (Radio Corp. of America, Princeton, N. J.). pp 391-403 of Properties and Use of MIS Structures. /Borel, Joseph (ed.). Grenoble, France; Centre d'Etudes Nucleaires (1969).

From Conference on properties and use of MIS structures; Grenoble, France (17 Jun 1969).

The mechanisms involved in radiation damage in MIS devices are briefly reviewed and it is shown that 1) they apply widely to the mass-produced MOS devices now available; 2) there is ground to hope for strong improvements in radiation hardness of MOS devices by finding process techniques which reduce hole-trap concentration in the oxide or other insulator substituted for the oxide; 3) the radiation-induced changes are not usually a true degradation but consist mainly of parameter shifts; and 4) the processes concerned are well enough understood and sufficiently predictable that methods of designing circuits and systems to accommodate the radiation effect can be devised. (France)

31171 RADIATION-INDUCED ELECTRON TRAPPING IN MIS TRANSISTORS. Danchenko, V.; Walker, J. D. Jr.; Brashears, S. S. (Goddard Space Flight Center, Greenbelt, Md.). pp 413-24 of Properties and Use of MIS Structures. /Borel, Joseph (ed.). Grenoble, France; Centre d'Etudes Nucleaires (1969).

From Conference on properties and use of MIS structures; Grenoble, France (17 Jun 1969).

Characteristics of thermal annealing of radiation induced electron trapping in thermally grown wet and dry silicon oxide MOS structures irradiated with 1.5 MeV electrons were investigated. Electron trapping was found to anneal in the temperature range of about 300 to 400°C. The tempering curves were analyzed for activation energies applying the concept of a distribution of energies, which resulted in two distinct energy values: 1.19 and 1.28 eV. The latter value seems to be a superposition of two peaks centered at 1.25 and 1.29 eV, but many more experimental points are necessary to substantiate this. There is experimental evidence that the activation energies calculated here are the activation energies of annealing of the electron traps themselves rather than thermal excitation of electrons into the conduction band of the oxide. It was experimentally demonstrated that most of the electron traps are induced by radiation. BT treatments using a variable gate bias indicated that the electron traps may have a positive Coulombic potential. (France)

31172 CONTRIBUTION TO THE STUDY OF MOS STRUCTURES IRRADIATED WITH ELECTRONS. Courat, J. P.; Sixou, P. (Paris Univ., Orsay, France). pp 425-38 of Properties and Use of MIS Structures. /Borel, Joseph (ed.). Grenoble, France; Centre d'Etudes Nucleaires (1969). (In French).

From Conference on properties and use of MIS structures; Grenoble, France (17 Jun 1969).

A MOS device was irradiated with electrons. The results obtained using different doses, energies, and bias conditions are presented. (France)

31173 DAMAGE MECHANISM PARAMETERS OF MOS DEVICES SUBJECTED TO IONIZING RADIATIONS. Buxo, J.; Martinez, A. (CNRS, Toulouse). pp 439-52 of Properties and Use of MIS Structures. /Borel, Joseph (ed.). Grenoble, France; Centre d'Etudes Nucleaires (1969). (In French).

From Conference on properties and use of MIS structures; Grenoble, France (17 Jun 1969).

The results concerning the irradiation of MOS devices and structures with x rays and electrons are given, and the recovery from damages induced in silicon oxide by the radiation is discussed. (France)

31174 EVOLUTION OF MOBILITY OF MOS TRANSISTORS SUBJECTED TO VARIOUS IRRADIATIONS. Gervais de Lafond, Y.; Giraud, J.-L.; Rouanet, J.-C. (Univ., Toulouse). pp 813-19 of Properties and Use of MIS Structures. /Borel, Joseph (ed.). Grenoble, France; Centre d'Etudes Nucleaires (1969). (In French).

From Conference on properties and use of MIS structures; Grenoble, France (17 Jun 1969).

The carrier mobility of MOS transistors subjected to various radiations was studied as a function of the polarization point and the radiation dose. (France)

31175 RADIATION-ENHANCED DIFFUSION: DEFECT PRODUCTION RATIO IN γ-IRRADIATED SILICON DETECTORS. Zhits, M. M.; Klimkova, O. A.; Niyazova, O. R.; Popov, N. V. Phys. Status Solidi (a); 10: No. 1, K23-6 (16 Mar 1972).

The role of radioinduced diffusion of Au in the radiation effects on surface-barrier Si detectors was studied by comparison of detectors with Au contacts and those fabricated from irradiated Si. α-particle energy resolution, pulse amplitude, and barrier capacitance were measured as functions of γ dose. Gold concentration profiles were also obtained; the radioinduced diffusion coefficient was determined to be 4×10^{-11} cm^2/sec. It is concluded that the changes in the electric characteristics are determined chiefly by introduction of Au levels into the forbidden zone of Si. (D.L.C.)

31176 RADIATION COMPENSATION CIRCUIT. Smith, Richard A. (to Secretary of the Navy). U. S. Patent 3,652,877. 28 Mar 1972. Filed 14 May 1969.

A radiation hardened circuit utilizing an energy-storage capacitor to supply power to a load via a magnetic coupler is described. Triggered, unidirectionally conductive active circuit elements connected between the capacitor and the magnetic coupler provide a discharge path for the capacitor to transfer power to the load during normal operation but provide another discharge path for the capacitor, inhibiting transfer of power to the load, when the circuit is exposed to radiation. (2 figures) (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 30691, 30955, 30978, 31081, 31447, 32489, and 32764.

31177 (BNWL-SA-4231) COMPLETELY IMPLANTABLE THREE CHANNEL TEMPERATURE BIOTELEMETRY SYSTEM. Decker, J. R.; Gillis, M. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1971]. Contract AT(45-1)-1830. 8p. (CONF-720508-1). Dep. NTIS.

From ninth annual Rocky Mountain bioengineering symposium and tenth international biomedical sciences instrument symposium; Omaha, NB. (May 1972).

A completely implantable three channel pulse modulated transmitter and corresponding external receiver have been developed to telemeter, from free ranging animals, body temperature and internal temperatures of an intracorporeal radioisotope heat source cooled by flowing blood. Temperatures ranging from 4 to 80°C can be telemetered over a range of 4 meters. Life expectancy of the device exceeds 10 months with calibration accuracy maintained to within 0.2°C. (auth)

31178 (CEA-N-1504) DIGITAL/ANALOG DECODER MODULE WITH AUTOMATIC SENSITIVITY CHANGEOVER. UTILIZATION AS A 0 TO 2 Mhz RATEMETER. Rigaudiere, Roger; Jeanmaire, Lucien (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec 1971. 37p. (In French). Dep. NTIS (U. S. Sales Only).

This module, which is compatible with the Renatran standard unit and possesses a 2/8 space requirement, enables the decoding of information provided by the M6DI-11 module so that it can be indicated on a recorder. It possesses two ranges allowing the decoding to be effected with a choice of two or three out of the six available decades of the Renatran scale. The linking together of these two modules forms a ratemeter unit, which allows count rates ranging from a few counts per hour or less to those corresponding to an activity limited by the M6DI-11 module (2 Mc/s); this is achieved by using the appropriate changeover. The changeover is effected automatically as a function of the activity by sliding towards the left the two or three decade groups corresponding to the required range. Lateral markers on the recorder indicate the position of the significant figures. When the activity to be measured is known to be large, a sampling operation may be adopted. (auth) (France)

31179 (IPP-9/2) STRONGLY FOCUSING OSCILLOTRON. Meyer, Erwin (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Jan 1972. 26p. (In German). Dep. NTIS (U. S. Sales Only).

A mass spectrometer in which quadrupole fields are used to stabilize ions by virtue of their mass is designed and investigated. These ions are then accumulated in a potential well. The mode of operation of the instrument is demonstrated by plotting stability diagrams. These are in good agreement with numerical calculations. The shape and position of the stability regions are theoretically interpreted. The expected pressure independence of the ion signal could be observed down to 1.6×10^{-11} torr. (auth)

31180 (LNF-72/18) SIMPLE ANALYSER FOR ELECTRON SCATTERING EXPERIMENTS ON NUCLEI. Del Fabbro, R.; Matone, G.; Pocci, V. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 28 Feb 1972. 10p. Dep. NTIS (U. S. Sales Only).

The design of a magnetic analyzer for the detection at very small angles of high-energy electrons scattered by nuclei is discussed. The angles and momenta of the scattered electrons and, at the same time, the bend of the incoming electron beam can be measured. The increase of angular and momentum resolution due to kinematic effects, multiple scattering, etc., was calculated by the Monte Carlo method; the resulting values are ±0.2° and ±2%, respectively. (6 figures, 2 tables) (R.W.R.)

31181 (NASA-SP-5951(1)) ELECTRONIC TEST AND CALIBRATION CIRCUITS. A Compilation. (National Aeronautics and Space Administration, Washington, D. C.). 1972. 20p. NTIS.

A compilation of 31 simple test and calibration circuits is presented in four sections including (1) testing electronic devices and components, (2) instrument and system design, (3) calibration and reference circuits, and (4) simple test procedures. (W.H.K.)

31182 (UCRL-73803) NADS MIDFAU (MID FREQUENCY ACQUISITION UNIT). Gibson, Terry (California Univ., Livermore. Lawrence Livermore Lab.). Mar 1972. 7p. (CONF-720312-2). Dep. NTIS.

From Underground nuclear test measurement symposium II; Menlo Park, Ca. (21 Mar 1972).

The NADS MIDFAU is an instrumentation system under development for use at the Nevada Test Site. MIDFAU will gather data at forward area experiments and format it for entry into the NADS Central Data Facility. The MIDFAU Data System consists of 63 instrumentation amplifiers, several types of signal conditioners, and a programmable variable format PCM encoder. MIDFAU has a service system, which may be time shared among several data systems, for the purpose of calibration, control, and status monitoring of the data systems. The service system will contain all necessary test equipment. (2 figures) (R.W.R.)

31183 (UCRL-73804) NADS LOFAU (LOW FREQUENCY ACQUISITION UNIT). Gibson, Terry (California Univ., Livermore. Lawrence Livermore Lab.). Mar 1972. 4p. (CONF-720312-3). Dep. NTIS.

From Underground nuclear test measurement symposium II; Menlo Park, Ca. (21 Mar 1972).

The LADS LOFAU is an operational instrumentation system for taking data from Nevada Test Site forward area experiments and entering it into the NADS Central Data Facility. The LOFAU data system consists of 61 low-level differential amplifiers, signal conditioning, and a PCM encoder that multiplexes the amplifier outputs. There is also a service system for on-line calibration of the data system and monitoring of the overall system status from the central facility. (R.W.R.)

31184 (UCRL-73816) PORTABLE DATA SYSTEM. Jackson, E. C. (California Univ., Livermore. Lawrence Livermore Lab.). 17 Mar 1972. 18p. (CONF-720312-10). Dep. NTIS.

From Underground nuclear test measurement symposium II; Menlo Park, CA. (21 Mar 1972).

A compact, shock resistant, portable instrumentation system for dynamic measurements at remote areas has been recently developed. The tape recorder, signal conditioners, VHF receiver, power supplies, etc., for up to 30 data channels fit in a 11″ × 15.5″ × 21.5″ weatherproof case. The battery powered system can be operated locally or by remote control via radio link or hardwire signals. Prototype units of this system have been used for ground motion and structural response measurements during CANNIKIN, MINIATA, and CARPETBAG events and a DOD-Sandia event. It is estimated that these measurements were made at one-fifth ($^1/_5$) the cost of conventional systems. Many features of the system contribute to this significant reduction in cost, but the major factor is its portability. This system does not require support for transportation, shock mounting, diesel generators, air conditioners, or a work trailer in the field. Other major features that contribute to the cost reduction are pre-calibration of transducer and system set-up and check-out prior to installation in the field. Characteristics of the system and results of typical measurements are presented. (auth)

31185 (UCRL-73839) MAGNETIC MATRIX ACQUISITION UNIT FOR THE NEVADA AUTOMATED DIAGNOSTICS SYSTEM. Hyne, A. D. (California Univ., Livermore. Lawrence Livermore Lab.). 28 Mar 1972. 11p. (CONF-720312-9). Dep. NTIS.

From Underground nuclear test measurement symposium II; Menlo Park, CA. (21 Mar 1972).

The Magnetic Matrix Recorder promises to be a device which can, with minimum protection, operate and survive in the hostile environment in which many transducers function. It is designed to convert to digital form and store wideband transient information. Stored data from a group of recorders can be read out serially, resulting in an appreciable reduction in cable plant costs. The Magnetic Matrix approach, using uniaxal anisotropic magnetic thin films, combines fast analog-to-digital conversion and magnetic storage in one step. The system is potentially inexpensive (suitable for expendable use) and rugged. An experimental magnetic matrix recorder has proven systems feasibility and determined performance limitations. Fieldable units are being built using solid-state strobe and readout circuitry. Research and development for an all-magnetic, passive, front-end unit is being conducted. (auth)

31186 PROGRAMMABLE DESK CALCULATOR AS AN AID IN ROUTINE WORK IN NUCLEAR MEDICINE. Wendhausen, H. (Univ., Kiel). Roentgenpraxis; 24: No. 11, 259-68(Nov 1971). (In German).

A Hewlett-Packard 9100 B desk calculator was equipped with magnetic cards as the program storage device and employed in the evaluation of thyroid diagnostics, thyroid therapy, and in hematological diagnostics. With a packet of four programs the evaluation time per patient is reduced to two to three minutes, and the imprinted tape may be attached directly to the case report. Flow diagrams for four suggested programmed computations are given and their derivations are discussed. (K.S.W.)

31187 E x B MASS-SEPARATOR DESIGN. Seliger, R. L. (Hughes Research Labs., Malibu, Calif.). J. Appl. Phys.; 43: No. 5, 2352-7(May 1972).

The equations of motion are developed and solved for ion trajectories inside an E × B type mass separator. Curves are presented which illustrate the focusing of the undeflected ion beam, the trajectories along which ions of different mass species disperse inside the separator channel, and the exit slopes of mass species leaving the separator, as functions of a separator strength parameter. For strong separators, beam focusing is significant and is shown to be nonaxisymmetric when the electric and magnetic fields are uniform and orthogonal. A method of correcting the astigmatism by tilting the magnetic pole pieces is presented. (auth)

31188 SENSITIVITY CONTROL FOR MASS SPECTROMETER. Bushman, Bliss M.; Whistler, Wayne J. (to Perkin-Elmer Corp.). U. S. Patent 3,648,047. 7 Mar 1972. Filed 13 Jul 1970.

In a mass spectrometer wherein gases of a mixture are ionized and respective ion beams are directed to collector plates or cups to generate proportional signals for determining the relative amounts of the several gases in the mixture, the sensitivity of the collector cup signals is maintained by adjusting the ionizing power supply as required to maintain the total of the signals from the collector plates or cups substantially equal to a reference signal. The total of the collector signals are compared with the reference signal by a summing amplifier. When the compared signals differ from a predetermined relation (e.g., equality) a proportional output signal is generated and applied to power control means to vary the level of power applied to ionize the mixture, and hence the levels of the collector signals, until the total of the collector signals is in said predetermined relation to the reference signal. Resistors associated with the collector plates or cups and with the reference signal source are selected so that the total of the collector signals and the reference signal are in said predetermined relation when the ion species collected are related to the gas species of interest. (auth)

31189 EQUIPMENT FOR X-RAY STRUCTURAL INVESTIGATIONS (REVIEW). Umanskii, M. M.; Kheiker, D. M. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 665-84 (May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 7-28(May-Jun 1971).

The review is devoted to the description of modern equipment for x-ray structural analysis. X-ray sources and detectors, chambers for x-ray structural research, equipment for small-angle scattering (which allows the shape and magnitude of submicroscopic particles to be determined), equipment for investigations under special conditions (high and low temperatures, high pressures), x-ray diffractometers, and automatic diffractometers, and densitometers for investigating single crystals are all described. The most important characteristics of industrially manufactured sealed tubes, chambers for x-ray structural research, and x-ray films are presented. (6 figures, 3 tables, 135 references) (auth)

31190 COMPACT POLARIZER FOR MAGNETIZATION OF THE FLUID IN NUCLEAR MAGNETIC RESONANCE INSTRUMENTS. Basin, L. A.; Ekaterinin, V. V. (Inst. of Nuclear Physics, Alma-Ata, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 888-9(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 198-9(May-Jun 1971).

The construction of a polarizer is described which is fabricated in the form of a shell-type magnet with an axisymmetric shape consisting of a magnetically hard core and a yoke in which the gap between the cylindrical surfaces of the yoke and the core is comparable in magnitude with the gap between their end surfaces. It is shown that, when such a polarizer is used in NMR measurement devices and magnetic-field stabilizers, distortion introduced into the investigated field by the polarizer decreases by one order, other conditions remaining equal. (2 figures) (auth)

31191 SCALING DECADE FOR FREQUENCIES UP TO 200 MHz. Dubik, L.; Tsisek, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 761-3(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 95-8(May-Jun 1971).

A scaling circuit which operates at frequencies of up to 200 MHz is described. The decade circuit is implemented using tunnel diodes and transistors according to a 2 + 5 logic with display by means of filament lamps. (2 figures) (auth)

31192 COINCIDENCE–ANTICOINCIDENCE CIRCUIT HAVING A NANOSECOND RESOLVING TIME. Rudenko, A. A. (Inst. of Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 758-60(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 92-4(May-Jun 1971).

The improvements in a previously published coincidence–anticoincidence circuit having a resolving time of approximately 3 ns and a switching speed of up to 10^8 pulses/s are described. (3 figures) (auth)

31193 TWO-CRYSTAL NEUTRON SPECTROMETER AND THE POSSIBILITIES OF ITS APPLICATION. Shil'shtein, S. Sh.; Marukhin, V. I.; Kalanov, M.; Somenkov, V. A. (Inst. of Atomic Energy, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 733-6(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 70-3(May-Jun 1971).

A two-crystal neutron diffractometer with a variable wavelength of monochromatic neutrons is described; it is mounted on the horizontal channel of the IRT-m pulsed reactor. (4 figures) (auth)

31194 STATUS AND PROBLEMS IN ON-LINE DATA PROCESSING. Wajima, Tsunetaka (Hitachi Ltd., Tokyo); Koyama, Kinji; Shiba, Kiminori; Oyamada, Masayuki; Murata, Yutaka. Nippon Genshiryoku Gakkaishi; 13: No. 9, 520-45(Sep 1971). (In Japanese).

In the nuclear field as well as in other fields, on-line computers have been employed to process a great many data at real time. The present status of data processing with on-line computers in Japan is introduced by classifying them into multi-purpose data processing systems and single-purpose data analyzing systems. The former include the MPDA-9 system in the Fast Critical Assembly, the DCA system in JAERI, the Power Reactor,,and the Nuclear Fuel Development Corp., etc. In the latter, examples of photo-analysis for spark chambers and bubble chambers, collection and processing of radioisotope imaging in nuclear medicine, and so forth are described. A general problem is that it is almost impossible to satisfy all the requirements of each user in case of large organizations installing such systems. The system often turns out to be inconvenient if it is decided to compromise each requirement. Therefore, it seems better that preparing the on-line data processing systems is centered on the level of the experiments. (Japan)

31195 PATH SEPARATION TYPE NON-MAGNETIC MASS SPECTROMETER. Kanematsu, Futoshi; Mima, Hiroshi (Osaka City Univ.). Shinku; 14: No. 12, 431-5(Dec 1971). (In Japanese).

A non-magnetic mass spectrometer of path separation type with parallel plane electrodes was studied. Its sensor consists of two side-plates and a rectangular box inserted between them. The box electrode on which a negative r.f. voltage of square wave is applied has two windows with grids on both sides. A collimated ion beam injected into the space between the box and the first side-plate along the tube axis is accelerated to the box and then decelerated between the box and the other side-plate after passed through the box. The composite ions in the beam disperse in direction corresponding to mass number and only ions directed along the tube axis can reach the collector through the exit collimator. In order to obtain mass spectra, the frequency of r.f. voltage was swept. It is found that the resolving power of the spectrometer studied here is 27 and the current efficiency is about 4% which is in good agreement with the expected values. The resolving power does not depend on the velocity distribution of ions. Theoretically obtainable efficiency would be 50%. A method to improve the resolving power was tested. Further projects are proposed to improve resolution and sensitivity. (auth) (Japan)

31196 METHOD OF AND APPARATUS FOR EXAMINING A BODY BY RADIATION SUCH AS X OR GAMMA RADIATION. Hounsfield, G. N. Canadian Patent 887,891. 7 Dec 1971. Priority date 23 Aug 1968, Great Britain.

In apparatus for examining a body by means of X or γ radiation, a two-dimensional matrix of elements of the body is exposed to radiation from a number of directions and the transmission of the radiation by a plurality of paths of small cross-sectional area through the body is measured, the directions and numbers of the paths being such that each element of the matrix is intersected by a group of paths which intersect different groups of elements. From these measurements, the absorption or transmission coefficients of the individual elements are calculated and used to produce a cathode ray tube display and/or a photograph. (Canada)

31197 IMAGE RECORDING WITH SEMICONDUCTOR DETECTORS AND VIDEO AMPLIFICATION DEVICES. Hermann, K.-H.; Krahl, D.; Kuebler, A.; Rindfleisch, V. (Siemens AG, Berlin. Siemens AG, Karlsruhe, Ger.). pp 236-72 of Electron Microscopy in Material Science. /Valdre, U. (ed.). New York; Academic Press, Inc. (1971).

From International school of electron microscopy; Erice, Italy (4 Apr 1970).

Two recording methods for electron microscopes are described including 1) the measurement of the current density at the highest image resolution by means of semiconductor detectors and 2) the conversion of the electron image into a video image. The arrangement of the devices is described, some possible applications are shown, and the efficiency and principal limitations of both methods are examined. It is shown that both methods favorably serve as supplements for each other. (W.H.K.)

31198 MASS SPECTROMETER WITH DOUBLE COLLECTOR FOR THE DEUTERIUM–HYDROGEN ISOTOPE RATIO, ESPECIALLY IN NATURAL WATER. Gaona, S.; Morales, P. (Univ. Nacional Autonoma de Mexico, Mexico City). Rev. Mex. Fis., Supl. Fis. Apl.; 20: 91-9(1971). (In Spanish).

A mass spectrometer with a two-fold simultaneous collection, for study of the isotopic ratio of deuterium–hydrogen, is described. The spectrometer has 4 cm of radius and 90° in the magnetic analyzer. The improvements in the instrument are the stability and size. The collectors are 1.5 cm apart and are contained in the same tube as the spectrometer. The double introduction system for analysis of the sample against a standard is described. (auth)

31199 LUNAR ORBITAL MASS SPECTROMETER. Hoffman, John H. (Univ. of Texas, Dallas). J. Mass Spectrom. Ion Phys.; 8: No. 4, 403-16(Apr 1972).

The Apollo 15 flight carried the first mass spectrometer to be flown beyond the earth's atmosphere. As part of the Lunar Orbital Science Experiments Package, it was designed to measure the composition of the atmosphere of the moon. The instrument, a dual collector, single-focusing sector-field spectrometer, was mounted on a 7.3 meter bi-stem boom extended from the service module and operated by a crew member from the command module during the lunar orbit and trans-earth coast phases of the mission. Approximately 90 hours of data were obtained showing many mass peaks of significant magnitude in lunar orbit, but with much reduced amplitude during trans-lunar coast. Pre-flight absolute calibration was done at the Langley Research Center Molecular Beam Facility. (auth)

31200 STIGMATIC FOCUSING PARTICLE SPECTROMETER WITH MASS AND ENERGY DISPERSION. Muenzenberg, Gottfried; Ewald, Heinz (Justus-Liebig-Univ., Giessen, Ger.). J. Mass Spectrom. Ion Phys.; 8: No. 4, 293-310(Apr 1972). (In German).

A stigmatic focusing particle spectrometer with mass and energy dispersion has been built and its properties have been examined. The spectrometer consists of a double-focusing (i.e., energy and directional focusing) combination of a magnetic with an electric sector field in connection with a magnetic field deflecting perpendicular to the mean plane of deflection of the first two fields. With such a spectrometer it is possible to measure the energy distribution of the particles of a definite mass number by variation of the field strength of only one field. The spectrometer has a rotational symmetric electron impact ion source. With a circular entrance diaphragm of 200 μ diameter, a mass resolution of 1400 and an energy resolution of about 2000 could be obtained. The spectrometer will be used for studies of atomic collision processes. (auth)

31201 TANDEM ION ANALYZER OF LARGE RADIUS. Rasekhi, H.; White, F. A. (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Mass Spectrom. Ion Phys.; 8: No. 4, 277-91(Apr 1972).

A mass spectrometric facility has been designed and constructed comprising two electrostatic and two magnetic 90° lenses, each with a mean radius of curvature of 122 cm. Both the electrostatic and magnetic components can be operated independently or programmed in tandem, permitting mass and energy resolution of primary ions and secondary species produced in collision processes. A special ion-detector system provides "on-line" monitoring of the primary ion beam and counting of secondary ions and neutral atoms at counting rates from 1/sec to 10^7/sec. Special features of the instrument make it useful in investigations of ion energy loss, charge exchange, sputtering, and ion implantation, as well as for isotopic abundance measurements. (auth)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

Refer also to abstract 30776.

31202 (K-P-3944) RECYCLING AND SOFTENING OF RECIRCULATING WATER BLOWDOWN FOR REUSE. Fowlkes, C. C.; Webb, B. R. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 16 Feb 1972. Contract W-7405-eng-26. 21p. Dep. NTIS.

Chromium and zinc based corrosion inhibitors in open recirculating water systems are considered. Future power loads at the Oak Ridge Gaseous Diffusion Plant will make the disposal of chromate and zinc corrosion inhibitors in the blowdown water mandatory. The capital expenditures and increased operating and maintenance costs associated with ion-exchange and chromate destruction processes encouraged efforts to find a simpler, less expensive method of removing chromate from the blowdown stream. One of these explorations led to the resoftening of the blowdown water. Operational results of one year's recycling and blending the recirculating water blowdown with raw makeup water and softening the mixture are covered. The chromate concentration in the blowdown water is unchanged by the softening process and is returned to the recirculating water systems for reuse. The zinc concentration is precipitated as zinc hydroxide and conveyed to the holding lagoon with softener blowdown for settling. This test proved that excellent calcium hardness reduction can be obtained continuously, utilizing the recycle concept with standard water softening equipment. This is the most economical approach to satisfy operational requirements and pollution abatement regulations. The equipment used in this process is standard water softening equipment used throughout the industry. (auth)

31203 (ORNL-TM-3722) CURRENT LIMITATIONS IN CALUTRONS. Alexeff, I. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 10p. Dep. NTIS.

A fundamental limit to the throughput of ^{235}U in a calutron (conventional mass-spectrograph) type isotope separator has been found. It is due simply to the particulate nature of the ion beam, and does not depend on any plasma instabilities or waves whatever. Essentially, it was found that, although the ion beam of a calutron is extracted from the ion source at some tens of kilovolts, the relative energy of the $^{235+}$U ions to the $^{238+}$U ions is only a fraction of one electron volt. This small relative energy produces the slow radial relative drift of ^{235}U to ^{238}U that results in isotope separation. However, when one charged particle drifts very slowly through an environment of other charged particles, it is extremely susceptible to multiple scattering. Thus, the directed relative velocity is easily lost. Reducing the beam voltage reduces this relative velocity and increases the undesired scattering. Increasing the beam current increases the number of scattering centers and also increases the undesired scattering. It can easily be shown that for a fixed, tolerable degree of multiple scattering, the minimum extractor voltage (volts) and the maximum beam current density j(amps/cm^2) are related by equation: $V^2/j = \text{constant}$. The exact value of the constant is difficult to compute, but a value of 3×10^{10} was found for U in a typical calutron field of ≈7 kG and an extractor voltage of 20 kV. (auth)

31204 ENRICHMENT OF URANIUM. Wright, W. J. K. (Australian Atomic Energy Commission, Lucas Heights). At. Energy Aust.; 15: No. 1, 2-8(Jan 1972).

A comparison is made between the gaseous diffusion and centrifuge process methods of uranium enrichment. The basic mechanisms of each process are outlined. The enriching effect per stage is lower in the diffusion plant, and the separative work capacity per stage is proportional to mass flow and can be increased by building larger stages, whereas centrifugation is dependent on design factors. Centrifuge plant output can be increased by installing more machines in parallel, but a diffusion plant is more dependent on initial design. Centrifuge units can be designed more nearly to approach on ideal cascade. Diffusion plants are more flexible in operation but require about five times as much electric power per unit output. A diffusion plant requires much greater quantities of cooling water, but much less maintenance. Australian interest in enrichment for a world market has increased with recent large ore discoveries. The profitability of an enrichment project is briefly examined. (Australia)

31205 HELICAL THREE-STAGE ISOTOPE SEPARATION. Bell, William A. Jr.; Johnson, Ray L. Jr.; Veach, Allen M. (to United States Atomic Energy Commission). U. S. Patent 3,649,827. 14 Mar 1972. Filed 13 Aug 1970.

An isotope separator is described of the type having an evacuated tank, a magnetic field through the tank, and an ion source and a receiver wherein the ion source is orientated at a slight angle to the magnetic field lines such that the stream of ions exiting from the ion source spiral along the magnetic field in a helical path, producing a three-stage separation after 540° of rotation, and the desired isotopic ions are collected in a receiver located at the 540° focus. (Official Gazette)

Isotopic Power Sources

31206 (AECL-PAK/Lib-34) RECHARGABLE BATTERIES. A Select Bibliography. Saleem, M. (Atomic Energy Centre, Lahore (Pakistan)). Oct 1971. 318p. Dep. NTIS (U. S. Sales Only).

A bibliography is presented of 651 abstracts of articles published between 1954 and 1970 on rechargable batteries for use in aerospace technology. The abstracts are arranged in chronological order by publication date within each of the following categories: nickel–cadmium batteries; silver–cadmium batteries; silver–zinc batteries; alkaline batteries; storage batteries; and electrodes. An author index is included. (L.C.L.)

31207 (HIT-4086-4) ADDITIONAL TESTING OF RADIOISOTOPE HEAT SOURCE SUBSYSTEMS FOR HEART DEVICES. Final Report. (Hittman Associates, Inc., Columbia, Md.). Mar 1971. Contract AT(30-1)-4086. 90p. Dep. NTIS.

Prior work with radioisotope heat source subsystems for heart devices has established some of the characteristics and shown such devices to be feasible from a technical viewpoint. Additional work has been performed to obtain information pertaining to long term behavior and operating characteristics. Heat loss rate from the Stirling insulation package was found to be 3.80W at a temperature of 1150°F, and 32% of the heat was found to be escaping through the gap between the bottom and side foils of the insulation. The package further demonstrated a capability to maintain a vacuum for periods of months while disconnected from the dynamic vacuum pumping station. Testing of the Rankine subsystem for several months disclosed no differences from the previous test data and further disclosed no change with time. Attempts were made to operate this subsystem while disconnected from the vacuum station in the same manner as with the Stirling, but it was never possible to leave the vacuum pump off for more than an hour. After this time, the internal pressure would become high enough that the pump would have to be reconnected to prevent potential damage to the foils. This behavior may be due to the higher operating temperature of the Stirling insulation. The titanium foils would be more reactive toward gettering gases at the higher Stirling temperatures. In addition, the design of the two insulation packages is different, and the Rankine would be more likely to have a problem since the heater and eutectic container are within the evacuated envelope and there are a number of electrical penetrations from the ambient into the envelope. Each of these items may contribute to the poorer vacuum behavior of the Rankine package. (auth)

Radiation Sources

Refer also to abstract 30941.

31208 (HPA-1) GUIDANCE ON THE TESTING OF SEALED SOURCES OF RADIOISOTOPES FOR LEAKAGE AND SURFACE CONTAMINATION. (Hospital Physicists' Association, London (England). Radiation Protection Committee). Jan 1970. 11p. Dep. NTIS (U. S. Sales Only). UK 22 pence.

The term sealed source is defined and the need to test such sources summarized. Various official requirements on such testing are described and factors determining frequency of testing and methods of testing given. An appendix lists practical methods of detecting and measuring the leakage of radium tubes. 23 references. (UK)

31209 DIAPHRAGM FOR HIGH-ENERGY RAYS. Scheininger, L. (to Siemens Aktiengesellschaft). Canadian Patent 887,893. 7 Dec 1971.

A diaphragm consisting of four adjustable blocks in a rectangular arrangement is used to delimit a beam from a source of high-energy radiation, e.g., in cobalt or cesium radiation equipment. In the prior art the aperture-defining faces of the blocks were cut by the radiation at a relatively large angle and the field of radiation, therefore, was not sharply defined. The invention achieves sharp definition by aligning the inner faces of the blocks with the source of radiation and pivotably suspending each block by universal joint means arranged in the immediate vicinity of the radiation source. Wedge shaped intermediate pieces may be placed between adjacent blocks, each having a resilient connection with an associated block to compensate for gaps between the blocks as they are adjusted. The confronting faces of an intermediate piece and its associated block are twisted so that the radiation cannot pass straight through between them in any setting of the diaphragm. (Canada)

31210 DEVELOPMENT OF A UNIFORM HIGH ENERGY GAMMA DISC RADIATOR. Bishop, G. B.; Cleaver, J. W. (Univ. of Liverpool). J. Brit. Nucl. Energy Soc.; 11: No. 2, 113-24(Apr 1972).

A uniform disc source was developed which emitted high-energy gamma radiation from the decay of ^{16}N. A standard source of this type was required to provide benchmark data on the penetration of 6.13 MeV gamma rays through different shielding materials and geometries. Disc designs with central and peripheral flow inlets were tested, the decay of the water-borne ^{16}N being compensated for by variation in water depth with disc radius. A parallel-sided disc was used to study the flow and to ascertain viscous, entry, and exit effects. A disc design with peripheral flow inlet and central outlet appeared to be the most promising for a uniform radiation. (auth)

Design and Fabrication

Refer also to abstract 30911.

31211 NEUTRON α,n-SOURCES BASED ON ^{241}Am AND ^{9}Be. Aleksandrov, B. M.; Bak, M. A.; Krivokhatskii, A. S.; Petrov, Yu. G.; Shlyamin, E. A. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 709-11(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 50-2(May-Jun 1971).

Neutron sources made of AmO_2 and powdered metallic Be having an identical geometric size but different ratios between Am and Be nuclei were developed. The method of space distribution of neutrons in water was used to obtain the relative neutron yields of the fabricated sources. For the case of a calibrated source, a ^{252}Cf spontaneous-fission source was used. The absolute neutron yields of the sources were equal to 7.0×10^3, 4.1×10^5, and 7.1×10^5 neutrons/s for sources containing 0.92, 55.7, and 97.5 mg of Am, respectively. The maximum specific neutron yield of the sources fabricated by the method discussed amounted to 64 neutrons per 10^6 α particles. (auth)

31212 PRIMARY RADIOACTIVITY STANDARDS. Perolat, J. P. (CEN de Saclay, Gif-sur-Yvette, France); Goenvec, H.; Vatin, R.; Laine, M. Bull. Inform. Sci. Tech. (Paris); No. 163, 19-27(Oct 1971). (In French).

The requirements demanded of primary radioactivity standards led to the choice of ^{241}Am and ^{90}Sr for α and β sources. For each radionuclide thirty samples (5 ml of solution) were prepared in quartz ampuls and thirty samples in ampuls made of a metallic alloy. The dimensions of these ampuls are completely reproducible, thus allowing nondestructive transfer measurements to be accurately made. During the filling, certain monitoring processes are used to ensure the validity. Decay schemes are defined. The radioactive purity of the solutions was studied. Various measurement techniques were used. An overall accuracy of 0.2% for ^{241}Am and better than 1% for ^{90}Sr was obtained. (France)

31213 NATIONAL PRIMARY STANDARD FOR THERMAL NEUTRONS. Capgras, A. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 163, 43-7(Oct 1971). (In French).

A primary standard thermal neutron source below the Cd cutoff has recently been redefined. It is based on a classical idea, the sigma pile, involving a single 10^8n/s 4π intensity Am–Be source in a graphite block, the entire assembly being maintained at a constant temperature of 22 ± 0.5°C. An attempt was made to minimize the correction terms, and to optimize the flux detection measurements. At the reference point, $n_{th}V_0 = 3.25 \cdot 10^4 ns^{-1} cm^{-2} \pm 1.5\%$, the epithermal flux being about 0.5% of the thermal density. (France)

31214 SECONDARY STANDARDS. Le Gallic, Y.; Thenard, M. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 163, 53-9(Oct 1971). (In French).

The users of radionuclides require reference standards having well defined activities, fluences and exposure rates. Problems encountered throughout the entire production process are discussed, in particular, preparation, radioactive purity determination, activity measurements, and accuracy. The uses of these standards in the calibration of $4\pi\ \gamma$ ionization chambers, low-activity detectors, liquid scintillator spectrometers, γ spectrometers, and radioprotection detectors are outlined. (France)

Industrial Uses

Refer also to abstracts 30619, 30784, 30813, 30827, 30946, and 31246.

31215 MODIFICATIONS TO IMPROVE SAFETY WITH TELETHERAPY UNITS. Van Roosenbeek, Earl R.; Ames, John C.; Simon, Billie G. (Univ. of Texas, Houston). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 114: No. 3, 631-5(Mar 1972).

Modifications to improve efficiency and safety of Theratron and Eldorado teletherapy units are described. Information and discussions are included on safety hazard incidents, safety circuits, and ancillary redundancy equipment. (J.R.D.)

31216 POSSIBLE USE OF GAMMA RADIATION IN WASTE WATER TREATMENT. Ramakrishnan, C. V. (M. S. Univ., Baroda, India). pp 1-15 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

Studies on the use of radiation to destroy microorganisms in water, sewage, and sewage sludge are reviewed. Disinfection seemed to be a function of total absorbed dose rather than dose rate. The possibility of using radiation for elimination of helminths is being explored. Radiation produces charged and oxidizing species that affect colloidal systems and thus may improve sedimentation rates, reduce or control septic conditions, and accelerate sludge dewatering. Evaluation of gamma radiation sources and pilot plant studies are discussed. (M.C.G.)

31217 SOME DESIGN CONSIDERATIONS OF PROCESS IRRADIATORS. Rao, S. M. (Bhabha Atomic Research Centre, Bombay). pp 17-22 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

Aspects of process irradiator design are discussed. Design considerations are given concerning radiation sources, product passage equipment, allowable radiation dose, source efficiency, product throughput rate, and economic feasibility. (J.R.D.)

LIFE SCIENCES

31218 ADVANCEMENT OF RADIOBIOLOGY. VOLUME III. 9th National Conference of the Italian Association of Medical Radiobiology, Varese, Italy, September 20–22, 1968. Martinenghi, C.; Bergonzi, M. (ed.). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 1-703(1968). (In Italian and English). (CONF-680991-(Vol.3)).

Separate abstracts were prepared on 32 papers presented at this conference. (C.H.)

For abstracts of individual papers see: 31222–31224, 31233, 31302–31315, 31336–31345, 31370, 31371, 31378, and 31386.

Radiation Effects on Biochemicals (External Source)

Refer also to abstracts 30837 and 30838.

31219 (CERN-71-16(Vol.1 and 2), pp 3-12) MATHEMATICAL MODEL FOR THE DEPENDENCE OF RADIATION INJURY CROSS SECTION ON LET. Kovalev, E. E.; Sakovich, V. A. (Ministerstvo Zdravookhraneniya SSSR, Moscow. Institut Mediko-Biologicheskikh Problem).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

A mathematical model is derived to show the dependence of radiation damage cross section (equatable here to RBE) on LET. The model could also take into account irradiation parameters other than LET. (E.R.B.)

31220 RADIO-PRODUCTS OF THYMINE IN THE PRESENCE OF ETHANOL. Zarebska, Zofia; Shugar, D. (Inst. of Biochemistry and Biophysics, Warsaw). Int. J. Radiat. Biol.; 21: No. 2, 101-14(Feb 1972).

Gamma-irradiation of neutral aqueous solutions of thymine in the presence of ethanol led to the formation of addition products with an α-hydroxyethyl substituent on C_6 of thymine. These products accounted for about 25 per cent of total products. One of the products, 6-(α-hydroxyethyl)-6-hydro-5-hydroxythymine, could undergo photochemical conversion to the parent thymine with concomitant elimination of acetaldehyde, on irradiation at 254 nm in aqueous medium. An additional product, probably arising as a result of secondary reactions, was 6-ethylthymine. The mechanisms of formation of the foregoing are formulated, some of the properties of the various products presented, and the possible radiobiological significance of these processes discussed. (auth) (UK)

31221 EPR STUDY OF THE NATURE AND PROPERTIES OF PARAMAGNETIC CENTERS IN γ-IRRADIATED PROTEINS. Sud'bina, E. N.; Pulatova, M. K.; Kayushin, L. P. (Inst. of Biological Physics, Pushchino, USSR). Biofizika; 16: No. 4, 596-602 (Jul-Aug 1971). (In Russian).

A detailed analysis was carried out and the ESR signals of individual paramagnetic centers were liberated from a total complex ESR spectrum observed in different proteins γ-irradiated at −196°C. Based on the study of the properties of paramagnetic centres, it was shown that the following paramagnetic centres occur in proteins under the effect of ionizing radiation at −196°C: trapped electrons; anion-radicals with unpaired electron localized on −S−S− bond; paramagnetic centres with unpaired electrons localized on aliphatic amino acid residues; and paramagnetic centres occurring when hydrogen atoms break away from the C_α carbon of the peptide chain. At room temperature, the paramagnetic centres were observed with the localization of the unpaired electron on oxygen atoms, of the hydrogen bond, and the paramagnetic centres RS. (auth)

31222 EFFECT OF LOW DOSES OF X-RAYS ON ISOLATED DEOXYRIBONUCLEIC ACID (DNA). I. RESULTS OBTAINED BY PHYSICO-CHEMICAL METHODS. Campagnari, F.; Bertazzoni, U. (EURATOM, Ispra, Italy). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 297-303(1968).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Dilute solution of DNA from calf thymus and SPP 1 phage were exposed to x-ray doses producing radiation damage to animal cells. The molecular weight of irradiated DNA was measured by physico-chemical methods; low shear viscometry and band sedimentation in ultracentrifuge were used for mammalian and viral DNA, respectively. The efficiency of the radiation injury was higher than that previously reported for direct measures following mild irradiation. 100 R yielded one single strand break per 7.9×10^6 daltons of intact viral DNA, and one double strand break per 76.7×10^6 daltons of calf thymus DNA, containing two single breaks per 11.8×10^6 daltons. The data are consistent with the hypothesis that doses of 10^2 R, lethal to most cells, cause "in vivo" chain breaks to mammalian DNA. (auth)

31223 EFFECT OF LOW DOSES OF X-RAYS ON ISOLATED DEOXYRIBONUCLEIC ACID (DNA). II. RESULTS OBTAINED BY ENZYMATIC METHODS. Campagnari, F.; Bertazzoni, U. (EURATOM, Ispra, Italy). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 304-11(1968).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Calf thymus DNA was exposed to x-rays and then tested for its priming properties for replicative and terminal deoxynucleotidyl transferases (DNA polymerases) from the same tissue. The replicative enzyme, which duplicates single stranded DNA templates, replicated non irradiated and moderately irradiated DNA primers at the same initial rate and to the same extent. A dose of 10,000 R reduced the level of final DNA duplication from 96 to 82 percent. The terminal enzyme, which elongates DNA chains from the 3'-OH end, recognized definitely the DNA exposed to less than 200 R. Following x-irradiation, single stranded DNA saturated the terminal deoxynucleotidyl transferase at lower concentrations of primer, while double stranded DNA enhanced greatly the polymerization rate both, at limiting and saturating amounts of primer. The data suggest that low doses of x-rays, which cause chain breaks to DNA, produced new and more active DNA molecules priming the end addition of deoxynucleotides by the terminal DNA polymerase from calf thymus. The test with the terminal enzyme is the first "in vitro" assay of a biological activity from mammalian preparations to give a positive response with low doses of x-irradiation. (auth)

31224 IMMUNOELECTROPHORETICAL AND RADIATION-HEMATOLOGICAL TEST WITH PENTOSANPOLYSULFOESTER (SP 54) BEFORE AND AFTER IRRADIATION BY 120 R, 600 R, AND 1200 R GAMMA-RAYS. Sachs, V. (Univ., Kiel); Szirmai, E.; Betsch, J.; (and others). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 671-80(1968).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

It was reported that SP 54, a pentosanpolysulfoester non-irradiated and irradiated at different doses of gamma rays, is not precipitated by anti-human-serum. The addition of irradiated SP 54 to blood prolonged significantly its coagulation time, in contrast to the unirradiated SP 54. (auth)

31225 INFLUENCE OF RADIATION-INDUCED ELECTROLYTE DISTURBANCES ON METABOLISM. IV. INVESTIGATIONS ON ACETALDEHYDE-CONSUMING YEAST. Rink, Hermann; Bergeder, Hans-Dietrich; Proemse, Baerbel (Univ., Bonn). Strahlentherapie; 142: No. 6, 739-45(Dec 1971). (In German).

Irradiated and non-irradiated samples of acetaldehyde-consuming baker's yeast show variable activation of oxygen-consumption and variable changes of the intracellular electrolyte concentration, in dependence of the extracellular potassium ionic concentration of the medium. Under the conditions of choice the aldehyde dehydrogenase is the limiting enzyme. It is shown that the acetaldehyde metabolism can be regulated via the intracellular concentration on potassium ions, which activates the potassium-dependent aldehyde dehydrogenase. The lower activibility of acetaldehyde-consumption following irradiation by potassium ions can be explained through the radiation-induced lower potassium concentration. The investigation gives a further example for the effect of radiation-induced electrolyte disturbance on the metabolism. (auth)

Radiation Effects on Cultured Cells (External Source)

31226 (CERN-71-16(Vol.1 and 2), pp 151-66) DOSE-EFFECT RELATIONS FOR DAMAGE TO MAMMALIAN CELLS AND TUMOURS BY RADIATIONS OF DIFFERENT QUALITY; IMPLICATIONS FOR RADIATION PROTECTION AND FOR CANCER THERAPY. Barendsen, G. W.; Broerse, J. J. (Gezondheidsorganisatie TNO, Rijswijk (Netherlands). Radiobiologisch Instituut).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The effects of high energy radiations of different qualities on cultured mammalian cells and tumors were determined. Dose-response relations (survival curves) were determined for radiations of different LET values. RBE values, as influenced by LET and dose and by the type of effect considered, were determined in comparison with x rays. The implications of these factors (dose, LET, and RBE) for radiation protection and cancer therapy are discussed. (E.R.B.)

31227 (LIB/Trans-366) IN VITRO STUDY OF THE EFFECT OF GAMMA RAYS ON HUMAN CHROMOSOMES. Mouriquand, C.; Gilly, C.; Wolff, C.; Patet, J. Translated by M. Ganez for Australian Atomic Energy Commission, from Int. J. Radiat. Biol.; 19: No. 3, 263-79(1971). 17p. Dep. NTIS (U. S. Sales Only).

Blood was collected from seven human donors who had never been exposed to radiation. Samples were gamma-irradiated from a ^{60}Co source in doses of 25 to 500 rads and leukocytes were prepared for cytological examination. Observations on numerical anomalies of chromosomes included hypodiploidy, hyperdiploidy, and tetraploidy. Structural anomalies included chromatid anomalies, chromosome anomalies, monocentric rearrangements, dicentrics, and fragments. The anomalies in chromosome number and structure are described in detail and relationships between radiation dose and chromosome anomalies are shown by means of graphs and tables. A discussion is presented of the present results in comparison to those reported in the literature. (H.L.W.)

31228 (UR-3490-86) EFFECTS OF BUdR LABELING ON RADIATION-INDUCED DNA BREAKAGE AND SUBSEQUENT REJOINING IN CULTURED MAMMALIAN CELLS. Sawada, S.; Okada, S. (Rochester Univ., N. Y. Div. of Experimental Radiology). [1970]. Contracts AT(30-1)-1286; W-7401-eng-49. 13p. Dep. NTIS.

Mouse leukemia cells in the exponentially growing phase were labeled with BUdR. The cells were x-irradiated at 10 krads/min, incubated for various lengths of time, and subjected to alkaline and neutral sucrose gradient centrifugation. The size of DNA was estimated by using three types of DNA, from ^{14}C-labeled T2, T4, and T7 phages. The BUdR labeling resulted in an increase of radioinduced DNA breakage of single-strand as well as double-strand, slowed down the rejoining processes for single-strand breaks, and inhibited the rejoining of double-strand breaks. The findings are similar to those observed in BU-labeled bacteria and may be responsible for the BUdR radiosensitization of cell killing but the exact manner of how they contribute to the increased cell killing is not known. (H.L.W.)

31229 EFFECT OF CAFFEINE ON THE INDUCTION OF MUTATIONS IN CHINESE HAMSTER CELLS BY ULTRAVIOLET LIGHT. Morrow, John (Univ. of Kansas, Lawrence). Mutat. Res.; 14: No. 4, 438-9(Apr 1972).

A discussion is presented of previously published data on the effects of caffeine on mutation induction in Chinese hamster cells by ultraviolet light. Further experiments on mutagenesis in mammalian cell systems employing both azaguanine resistance and other markers are being conducted. (H.L.W.)

31230 STUDIES ON BIOCHEMICAL AND CELLULAR, LET DEPENDENT EFFECTS OF IONIZING RADIATION IN SYNCHRONOUS MAMMALIAN CELL SYSTEMS. Wiley, Albert Lee Jr. Madison, Wis.; Univ. of Wisconsin (1972). 215p. University Microfilms Order No. 72-9151.

Thesis.

In the study of effects on nucleic acid synthesis, RNA transcription is of particular interest because of its possible relationship to both cell death and carcinogenesis. The uptake of RNA precursor into HeLa cells, synchronized by the vinblastine technique of Pfeiffer and Tolmach, was significantly depressed immediately following 750 rads of gamma irradiation at highly specific cell ages (G_1–S and late S). Asynchronous cells, however, exhibited no such radiosensitivity. We interpret these results as evidence that RNA synthesis is, in synchronized cells, a cell cycle dependent, radiosensitive process with low LET irradiation. These studies were extended to the parasynchronous regenerating LAf$_1$ mouse liver system where there was no significant depression of the rate of RNA synthesis immediately following x-irradiation (450 R and 950 R) during any phase of the cell cycle studied (G_0, early G_1, G_1–S, and G_2–M). However, 2.6 MeV cyclotron neutron irradiation (for doses between 250 and 520 rads) caused immediate depression of the rate of RNA synthesis during G_0, G_1–S, and G_2–M ($p < 0.05$) and probable depression during early G_1 ($p < 0.10$), suggesting cell cycle independence of RNA synthesis with high LET irradiation. Thus, considering both the HeLa and regenerating liver cell results, transcription may be a radiosensitive process which is cell cycle dependent for low LET radiations and cell cycle independent for high LET radiations. Because of known latent damage to chromosomes by fission neutron irradiation and because of possible relevance to the carcinogenic endpoint, it was of interest to consider the possibility of latent, LET dependent effects of ionizing radiation on nucleic acid synthesis in the LAf$_1$ mouse liver system. We noted that G_0 liver cells exposed to x-rays (550 R or 300 R) demonstrated no significant inhibition in the rate of RNA or DNA synthesis when these cells were stimulated to proliferate by partial hepatectomy, at 1 day or 9 months following the irradiation. However, the data does suggest that prior irradiation of G_0 liver cells with either fission neutrons (300 rads) or 2.6 MeV cyclotron neutrons (150 and 370 rads) caused a decrease in the rate of RNA synthesis (at 5.5 hours and 32 hours after partial hepatectomy) when the neutron irradiation was given 1 and 9 months prior to surgery. A 38% decrease in the rate of DNA synthesis, stimulated by partial hepatectomy at 9 months after the neutron irradiation (175 rads) of G_0 liver cells, was also suggested. In addition the data showed a delayed onset of DNA synthesis following partial hepatectomy for 1 year old control mice (compared to 3 month old control mice). As a pertinent cellular endpoint and as a followup on the work of Cole and Nowell, we also studied the cell cycle dependence of high and low LET radiations on hepatoma induction in male LAf$_1$ mice. Although partial hepatectomy (either 24, 36.5, or 48 hours before, or 2 to 3 months after 200 rads of fission neutron or gamma irradiation) significantly enhanced the carcinogenic endpoint, no significant cell cycle dependence for either type of radiation was noted. The data also established that fission neutron irradiation is 2 to 3 fold more effective for hepatoma induction than γ-irradiation. (Diss. Abstr.)

31231 STUDY ON GAMMA IRRADIATION OF CULTURED HUMAN CELLS AS AFFECTING THE REPRODUCTION OF HERPES SIMPLEX VIRUS. Andonov, P.; Todorov, S.; Dundarov, S.; Ivanov, B.; Mineva, E. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 155-63(1967).

The effects of high doses of radiation on virus development in cultured cells and the concomitant changes manifested in the cells were studied. Cultured human cells were exposed to ^{60}Co γ radiation at doses of 50000, 100000, or 350000 R and subsequently infected with Herpes simplex virus immediately or 24, 48, or 72 hrs postirradiation. Cell counts, cytological changes, carbohydrate metabolism, and macromolecular synthesis were determined at 24, 48, and 72 hr postirradiation. Virus production was determined 24 and 48 hr following infection. It was concluded that apparently disintegrations of cellular correlative mechanisms occurring at high doses of γ rays exert no substantial effect on the reproduction of Herpes simplex virus. (E.R.B.)

31232 RADIOBIOLOGICAL METHODS AND PROBLEMS OF VIRUS/CELL INTERACTIONS. Todorov, S. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 149-53(1967).

The combined use of virological, cytological, and radiobiological methods to investigate several aspects of virus/cell interactions is discussed. Among the interactions included in the discussion are: the evolution of non-irradiated virus in irradiated cells; the process of viral infection in cells involved in the repair of radiation damage; and the effects of radiation on latent virus infected cells such as is the case in lysogenic bacteria. (E.R.B.)

31233 HISTOPHOTOMETRIC RESEARCH ON CELL NUCLEI OF IRRADIATED MAMMALS. Ballaira, L.; Piccotti, F.; Isoardi Pons, A. (Univ., Turin). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 273-9(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Microspectrophotometric measurements were made on the DNA content of nuclei after staining with Feulgen's reagent; the margin of error was less than 5%. Determinations were made on interphase and metaphase nuclei of Ehrlich ascites tumor cells at intervals following irradiation with 2000 R. Results for non-irradiated material showed extinction value dispersions of the interphase nucleus around the diploid and tetraploid modal values. After irradiation the dispersion showed a remarkable increase, particularly in polyploid values. The data make it possible to observe different aspects of damage to chromosomes and DNA synthesis. Results of single photometric measurements on metaphase plates are also discussed. (H.L.W.)

31234 HIGH SENSITIVITY OF XERODERMA PIGMENTOSUM CELLS TO THE CARCINOGEN 4-NITROQUINOLINE-1-OXIDE. Takebe, Hiraku; Furuyama, Jun-ichi; Miki, Yoshiharu; Kondo, Sohei (Osaka Univ.). Mutat. Res.; 15: No. 1, 98-100(May 1972).

The sensitivity of normal human skin cells and skin fibroblasts from Xeroderma pigmentosum (XP) patients to uv radiation and the carcinogen, 4-nitroquinoline-1-oxide (4NQO), in vitro was compared. Based on the slopes of survival curves following treatment, the skin fibroblasts from XP patients were 13 times more sensitive to uv radiation and 6 times more sensitive to 4-NQO than were the normal human skin cells. (E.R.B.)

31235 ABNORMAL RATE AND DURATION OF ULTRAVIOLET-INDUCED THYMIDINE INCORPORATION INTO LYMPHOCYTES FROM PATIENTS WITH XERODERMA PIGMENTOSUM AND ASSOCIATED NEUROLOGICAL COMPLICATIONS. Robbins, Jay H.; Kraemer, Kenneth H. (National Institutes of Health, Bethesda, Md.). Mutat. Res.; 15: No. 1, 92-7(May 1972).

Skin cells from patients with Xeroderma pigmentosum (XDP) have an impaired ability to repair uv-radioinduced pyrimidine dimers in DNA. The present study investigates this repair ability in peripheral blood lymphocytes from XDP patients. Repair ability was determined by measuring the uv-radioinduced (unscheduled) incorporation of ^{3}H-thymidine (^{3}H-TdR) into the lymphocytes in vitro. Lymphocytes were obtained from normal humans and from XDP patients with and without CNS involvement. The cells were irradiated in vitro, incubated with ^{3}H-TdR, and examined for ^{3}H-TdR incorporation at 1, 3, and 21 to 24 hrs postirradiation. The lymphocytes from the XDP patients exhibited a lower rate and longer duration of ^{3}H-TdR incorporation than those from normal humans. Dose-response curves for ^{3}H-TdR incorporation by all three sets of lymphocytes were similar in shape. (E.R.B.)

31236 EFFECTS OF X-RAYS ON THE INCORPORATION OF TRITIATED THYMIDINE BY HUMAN CANCER NODULES IN LONG TERM ORGAN CULTURES. Beaupain, Rene (CNRS, Nogent-sur-Marne, France). Compt. Rend., Ser. D; 274: No. 4, 588-91(24 Jan 1972). (In French).

The synthesis rate for DNA in nodules of Z200 type tumors in long term cultures after an x ray dose of between 300 and 600R does not decrease during the first 24 hours following the irradiation. Inhibition of the synthesis occurs after 24 hours. The long term survival and growth of these nodules is possible. In contrast, the inhibition of the DNA synthesis after a dose of between 1200 and 2400R occurs more quickly (5 hours after the irradiation). This inhibition is maintained or increases during the 48 hours following the irradiation. The survival of these nodules is only a short term effect. (France)

Radiation Effects on Microorganisms (External Source)

Refer also to abstract 31232.

31237 (CERN-71-16(Vol.1 and 2), pp 122-32) ESTIMATION OF BIOLOGICAL EFFICIENCY OF SECONDARY RADIATION OF 70-GeV PROTONS. Akoev, I. G.; Fomenko, B. S.; Leonteva, G. A.; Achmadieva, A. H.; Livanova, I. A.; Lebedev, V. N.; Lukanin, V. S.; Yurov, S. S. (Akademiya Nauk SSSR, Moscow. Institut Biologicheskoi Fiziki. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The effects of high-energy secondary radiations from a 70-GeV proton beam on the survival of bacteria and bacteriophages and on the frequency of chromosome aberrations in seeds were determined. The materials used in the investigation were Escherichia coli, bacteriophage T$_4$Br$^+$, and Vicia faba seeds. The RBE values of the secondary radiations for each of the effects indicated were determined in comparison to ^{137}Cs γ rays. (E.R.B.)

31238 EFFECT OF AN R FACTOR ON RESISTANCE OF SALMONELLA TYPHIMURIUM TO RADIATION AND CHEMICAL TREATMENT. MacPhee, D. G. (Univ. of East Anglia, Norwich, Eng.). Mutat. Res.; 14: No. 4, 450-3(Apr 1972).

Treated and control samples of Salmonella typhimurium were diluted in saline and duplicate samples were plated on nutrient agar. Effects of the R factor, R-Utrecht, on resistance of S. typhimurium to ultraviolet and x radiation, thymine deprivation, MMS, and NTG were studied and graphs are presented to show results. The results established that the R factor partially protected the cells against lethal effects of all agents studied. It is suggested that the protective effect of R-Utrecht may be due to the presence on the plasmid of one or more genes whose products function in the repair replication or recombinational repair systems. (H.L.W.)

31239 ULTRAVIOLET-KILLING AND PHOTODYNAMIC-KILLING IN MUTANTS OF ESCHERICHIA COLI. Harrison, A. P. Jr.; Hafner, J. L.; O'Bryan, C. (Univ. of Missouri, Columbia). Contract AT(11-1)-2010. Mutat. Res.; 14: No. 4, 447-9(Apr 1972).

Several strains of Escherichia coli were exposed to ultraviolet radiation from a germicidal lamp and to illumination from blue fluorescent lamps for photodynamic tests. Graphs are presented to show killing of the cells by photodynamic action and by ultraviolet radiation. A correlation between susceptibility to photodynamic killing and to ultraviolet killing was found in some mutants but not in others. Various factors causing the different susceptibilities are discussed. (H.L.W.)

31240 MUTATION IN ESCHERICHIA COLI ENHANCING THE UV-MUTABILITY OF PHAGE λ BUT NOT OF ITS INFECTIOUS DNA IN A SPHEROPLAST ASSAY. Wackernagel, Wilfried; Winkler, Ulrich (Ruhr-Univ., Bochum, Ger.). Mol. Gen. Genet.; 114: No. 1, 68-79(1972).

A mutant (called mul) was isolated from E. coli AB1157 which increases up to 13 fold the rate of clear plaque mutations of extracellularly uv-irradiated phage λ. The mul-mutation does not affect the uv-mutability of T4rII mutants or various bacterial markers and therefore seems to act specifically on uv-irradiated phage λ. However, when spheroplasts prepared from mul cells were infected with either irradiated or unirradiated λ-DNA equal frequencies of clear plaques were produced. As there is indirect evidence (host cell reactivation) that the spheroplasts do not significantly exclude irradiated phage DNA it seems that the mul phenotype can be expressed only in complete cells. The mutation responsible for the mul phenotype has been mapped by conjugation and transduction to be located between the markers pyrE and ilv and probably marks a new gene. The mul mutation does not increase the uv-sensitivity of the cells nor does it affect their ability to perform host cell reactivation. The presence of a recA allel in a mul mutant abolishes the uv-mutability of phage λ. (auth)

31241 BIOCHEMICAL COMPOSITION OF THE PREPARATIONS OBTAINED FROM SH. FLEXNERI 550 CULTURES AND THEIR MUTANTS WITH INCREASED RADIORESISTANCE. Sinilova, N. G.; Pershina, Z. G.; Duplishcheva, A. P.; Ivanov, K. K. (Inst. of Epidemiology and Microbiology, Moscow). Zh. Mikrobiol., Epidemiol. Immunobiol.; 48: 102-7(Aug 1971). (In Russian).

There was found a difference in the basic chemical composition of radioresistant mutants of Shigella flexneri obtained by numerous gamma-irradiations, in comparison with the initial culture. A reduced protein and carbohydrate, but elevated lipid content was found in the cells. A change of qualitative and quantitative carbohydrate composition of the polysaccharide component of an O-somatic antigen was noted. Such changes are similar to those occurring in S-R dissociation. (auth)

31242 LETHAL EFFECT OF ALKYLATING AGENTS OR ULTRAVIOLET LIGHT ON THE GAMMA-RAY RESISTANT PARENT STRAIN AND A GAMMA-RAY SENSITIVE STRAIN OF THE CELLULAR SLIME MOLD, DICTYOSTELIUM DISCOIDEUM. Payez, J. F. (Pennsylvania State Univ., University Park); Deering, R. A.; Freim, J. O. Jr. Mutat. Res.; 15: No. 1, 82-5 (May 1972).

The effects of the monofunctional alkylating agents ethyl methanesulfonate and methyl methanesulfonate, the bifunctional alkylating agent nitrogen mustard, and uv radiation on the survival of vegetative cells of a γ-radioresistant strain (NC-4) and a γ-radiosensitive strain (γS-13) of the cellular slime mold, Dictyostelium discoideum, were studied. Cells of the γS-13 strain were rapidly inactivated by much lower concentrations of all three alkylating agents than were required for inactivation of the NC-4 strain cells. Cells of the NC-4 strain showed little effect for short term treatment times with the alkylating agents, with a subsequent more rapid decrease in survival at longer times. The response was more pronounced at high concentrations. The response of the two strains to uv radiation was similar to their responses to the alkylating agents. (E.R.B.)

31243 ULTRAVIOLET INACTIVATION AND EXCISION-REPAIR IN BACILLUS SUBTILIS. II. DIFFERENTIAL INACTIVATION AND DIFFERENTIAL REPAIR OF TRANSFORMING MARKERS. Bron, Sierd; Venema, Gerard (Univ., Groningen, Netherlands). Mutat. Res.; 15: No. 1, 11-22(May 1972).

Ultraviolet inactivation of transforming Bacillus subtilis markers was studied with the aid of an eightfold auxotrophic recipient and its excision-repair-deficient derivative. The results allow the following conclusions. Wild-type B. subtilis cells are able to repair approximately 80% of the uv-induced lesions causing inactivation of transforming activity in uv-sensitive recipients; saturating amounts of donor DNA increase the apparent marker sensitivities. This phenomenon is most pronounced in transformation of uv-sensitive recipients; various markers are inactivated to different degrees, both when assayed on the wild-type as well as on the uv-sensitive strain; various markers are repaired to different degrees in the wild-type recipient. The results favor the hypothesis that in our system differential uv inactivation of transforming markers is mainly due to differences in the frequency or distribution of potential photochemical lesions in the transforming segments of DNA. (auth)

31244 ULTRAVIOLET INACTIVATION AND EXCISION-REPAIR IN BACILLUS SUBTILIS. I. CONSTRUCTION AND CHARACTERIZATION OF A TRANSFORMABLE EIGHTFOLD AUXOTROPHIC STRAIN AND TWO ULTRAVIOLET-SENSITIVE DERIVATIVES. Bron, Sierd; Venema, Gerard (Univ., Groningen, Netherlands). Mutat. Res.; 15: No. 1, 1-10(May 1972).

An eightfold auxotrophic strain of Bacillus subtilis was constructed. It was about equally well transformable for all markers. When this strain was used as recipient in transformation, single marker transformation frequencies of 0.5 to 2.0% were obtained. The markers were located relatively close to each other using marker frequency analysis. Two uv-sensitive derivatives, equally well transformable as the parental multiple auxotroph, were isolated. One was highly sensitive to uv irradiation, was host cell reactivation-negative and did not show DNA breakdown or recovery of DNA synthesis after exposure to uv. Using uv-inactivated transforming DNA, this strain's transformability was strongly reduced as compared with both the uv-resistant parental strain and the other, moderately uv-sensitive, strain. (auth)

31245 CHANGE OF MICROFLORA, ESPECIALLY ACTINOMYCETE FLORA IN (γ)-FIELD SOIL. Araragi, Michio; Ishizawa, Shuichi (National Inst. of Agricultural Sciences, Tokyo). Nogyo Gijutsu Kenkyusho Hokoku, B; No. 22, 59-84(Jan 1971). (In Japanese).

Three experimental plots were γ-irradiated at distances of 10, 30, and 80 meters from the ^{60}Co source of 3,004 Ci for 20 hrs per day. Dose rates in each plot were 16.3 R/h, 2.02 R/h, and 0.225 R/h, respectively. This investigation was continued for three yrs, and the results are as follows: Irradiation effect was largest upon actinomycetes and least on bacteria. Decrease of the actinomycete population was evident in the upper part of the 10 m plot one month after the start of irradiation, and the population level was lowered to about one fourteenth of the control plot after 3 yrs. Count of fungi was decreased to one eighth, and it was observed that fungal flora also changed. The irradiation effect on the bacterial population was not evident because of its large variation at each determining period. Count of nitrifiers was, however, decreased evidently. Azotobacter was more or less tolerant. As to the effect on the actinomycete flora, the count of the Streptomyces A group (chromogenic, non-proteolytic, non-spiral former) and the Streptomyces C group (chromogenic, proteolytic, non-spiral former) were peculiarly decreased. Since it was the general trend that the number of actinomycete groups decreased with increasing dose of the irradiation, the actinomycete flora seemed to be simplified. There was no apparent effect on the physical or chemical properties of the soil. (Japan)

31246 RADIATION PRESERVATION OF FRUIT JUICES IN COMBINATION WITH FREEZE-CONCENTRATION. Kiss, I.; Farkas, J. (Central Food Research Inst., Budapest). Int. J. Appl. Radiat. Isotop.; 23: No. 4, 161-71(Apr 1972).

Juice was obtained of fresh strawberries, apples, and grapes The juice was clarified and then cryoconcentrated to different water activities (0.96 to 0.87). A ^{60}Co radiation source was used for treatment. The samples were stored at 20 to 22°C. The storage life, color, and sensory quality of the samples were studied as a function of radiation dose and water activity. It was established that a cryoconcentrate of 0.90 to 0.92 water activity when treated with 0.8 to 1.3 Mrad, dependent on the initial cell count, may be considered microbiologically stable at a storage temperature of 20 to 22°C and its organoleptic quality is satisfactory. (auth)

31247 EVIDENCE FOR NUCLEUS INDEPENDENT STEPS IN CONTROL OF REPAIR OF MITOCHONDRIAL DAMAGE. I. UV-INDUCTION OF THE CYTOPLASMIC PETITE MUTATION IN UV-SENSITIVE NUCLEAR MUTANTS OF SACCHAROMYCES CEREVISIAE. Moustacchi, E. (Institut du Radium-Biologie, Orsay, France). Mol. Gen. Genet.; 114: No. 1, 50-8(1972).

The induction of the cytoplasmic petite mutation by ultraviolet light in 21 uv-sensitive (rad) nuclear mutants of Saccharomyces cerevisiae was compared to that in the wild type. Six rad mutants showed an increased sensitivity and two were less sensitive than the wild type. Modifications in the dose-response paralleled that of uv-induced reversion in one nuclear locus (hi_1) studied. In these eight mutants the repair of uv-induced mitochondrial lesions seems to be under nuclear control. A block in the repair steps controlled by eleven of the other rad genes studied did not interfere with the repair of mitochondrial damage. In strains carrying a mutation in any one of these genes, the dose-response curve for petite induction could be superimposed on that of the wild type even though they differed from the wild type in respect of nuclear gene reversion. These steps of the mitochondrial repair pathway (s) are therefore likely to be controlled by a nuclear and/or a cytoplasmic genetic determinant whose product acts specifically on mitochondrial lesions or it may be that the products of these genes are not required in the process of induction of petites. (auth)

Radiation Effects on Plants (External Source)

Refer also to abstract 31237.

31248 (STI/PUB-297) INDUCED MUTATIONS AND PLANT IMPROVEMENT. Panel Proceedings Series. Proceedings of a Latin American Study Group Meeting, Held in Buenos Aires, 16-20 November 1970. (International Atomic Energy Agency, Vienna (Austria)). Jan 1972. 563p. (In English and Spanish). (CONF-701125). IAEA $16.00.

Separate abstracts were prepared for eighteen papers presented at the conference. An additional thirty papers are included on various aspects of mutation induction for plant improvement. (H.L.W.)

For abstracts of individual papers see: 31256–31272 and 31362.

31249 PRELIMINARY STUDIES ON FRUIT SET AND SEED PRODUCTION FROM RECIPROCAL CROSSES BETWEEN CONTROL AND X-RAY TREATED SERIES IN ALYSSUM MINIMUM, PHLOX DRUMMONDII, ACROCLINIUM ROSEUM, AND CENTAUREA CYANUS. Bose, S.; Hati, A. (Univ. of Calcutta). Sci. Cult. (Calcutta); 37: No. 7, 346-7(Jul 1971).

Seeds of Alyssum minimum, Phlox drummondii, Acroclinium roseum, and Centaurea cyanus were exposed to 20 and 40 kR of x radiation. The resulting plants were crossed with unirradiated plants and the results were tabulated. It was found that production of seeds and fruit of these plants was lower than that of crosses between control plants. (H.L.W.)

31250 MUTAGENESIS IN RELATION TO PLOIDY LEVEL. Symposium Held at Ibaraki, Japan, July 17-18, 1970. Gamma Field Symp.; No. 9, 1-93(1970). (In Japanese and English). (CONF-700726).

Separate abstracts were prepared for five papers presented at the conference. An additional two papers were presented on polyploidy in plants. (H.L.W.)

For abstracts of individual papers see: 31251–31255.

31251 POLYPLOIDY AND RADIOSENSITIVITY IN HIGHER PLANTS. Ichikawa, Sadao (Kyoto Univ.). Gamma Field Symp.; No. 9, 1-17(1970).

From Mutagenesis in relation to ploidy level symposium; Ibaraki, Japan (17 Jul 1970).

The relationship between polyploidy and radiosensitivity in higher plants is discussed. A review of data from the literature on experiments with wheat, tobacco, and other plants as well as experimental data on Rumex and Tradescantia led to the conclusion that the radiosensitivity of each species is determined principally by the interphase chromosome volume characteristic of each species, but that genetic redundancy sometimes acts as a modifier of the radiosensitivity in polyploids. In the case of comparison between a diploid and its artificially induced autopolyploid, where the chromosome volume is unchanged, the influence of the modifier (genetic redundancy) becomes evident. In the case of allopolyploid or natural polyploid vs. diploid, on the other hand, a higher extent of differentiation has resulted in a greater difference in the main factor, and thus the effect of the main factor tends to become more evident and the influence of the modifier tends to disappear. (H.L.W.)

31252 RADIATION RESISTANCE AND PLOIDY IN THE CELLULAR SLIME MOLD DICTYOSTELIUM DISCOIDEUM. Kananishi, Nobuzi; Yanagisawa, Kaichiro (Tokyo Metropolitan Isotope Research Inst.). Gamma Field Symp.; No. 9, 19-31 (1970).

From Mutagenesis in relation to ploidy level symposium; Ibaraki, Japan (17 Jul 1970).

The sensitivity of the haploid and diploid strains of the cellular slime mold Dictyostelium discoideum to gamma and uv irradiation was studied. The results indicated that the spores and myxamoebae of the haploid showed high resistance compared to those of the diploid. Both the haploid and diploid expressed much stronger resistance to gamma than other organisms, while their resistance to uv was not that strong. Many mutants were induced by gamma irradiation. The rate of mutation was much higher in the haploid than in the diploid. In both the haploid and diploid strains, the myxamoebae showed rather strong resistance to gamma and uv irradiation than the spores. (auth)

31253 RADIATION-INDUCED DIPLOID LINES DERIVED FROM A HAPLOID RICE PLANT. Tanaka, Sachihiko (National Inst. of Radiation Breeding, Ibaraki, Japan). Gamma Field Symp.; No. 9, 43-56(1970).

From Mutagenesis in relation to ploidy level symposium; Ibaraki, Japan (17 Jul 1970).

Haploid rice plants which had been propagated vegetatively from a single spontaneous haploid plant of the variety Norin No. 8 were exposed to chronic gamma rays for the purpose of studying induction of somatic mutation in haploid plants and of breeding pure lines by duplication of chromosome complement of haploid plants. Diploid sectors were frequently induced on irradiated haploid plants and more than 50 per cent of the resulting diploid lines showed the same or a higher purity than the mother variety. Two fifths out of the radiation-induced pure lines seemed to be true breeding mutant lines having small but significant changes of characters. It is concluded that chronic irradiation of haploid plants is one of the most effective techniques to produce pure mutant lines of rice and that close attention should be paid to these lines for rice improvement. Micro-mutations induced in haploid cells should not only be easily transmitted to pure lines but chromosomal aberrations induced in haploid cells might be rarely transmitted by duplication of micro-mutated or aberrant chromosome complement of irradiated haploid cells. (auth)

31254 SOME PROBLEMS IN RADIATION BREEDING OF WHEAT AND BARLEY. Toda, Masayuki (Nagano Agricultural Experiment Station, Japan). Gamma Field Symp.; No. 9, 57-67 (1970).

From Mutagenesis in relation to ploidy level symposium; Ibaraki, Japan (17 Jul 1970).

The difference in responses to radiation between wheat and barley having different ploidy levels was studied from the data obtained in the practical radiation breeding to improve low lodging-resistance in a wheat and a barley variety. Clear differences between two crop plants were observed in survival rate, mutation rate, kind of the predominant mutations, occurrence of the dominant mutations, degree of decrease of culm length, number of ears and yield in the induced short-culm strains, and the efficiency of obtaining true breeding mutant strains. All the differences except survival rate may be explained in connection with higher tolerance to chromosome aberrations in the case of polyploid wheat and with lower tolerance to those in diploid barley. (auth)

31255 TRANSFER OF LEAF-RUST RESISTANCE FROM RYE TO WHEAT BY INTERGENERIC ADDITION AND TRANSLOCATION. Mukade, Koichiro; Kamio, Masayoshi; Hosoda, Kiyoshi (Tohoku National Agricultural Experiment Station, Morioka, Japan). Gamma Field Symp.; No. 9, 69-87(1970). (In English and Japanese).

From Mutagenesis in relation to ploidy level symposium; Ibaraki, Japan (17 Jul 1970).

With an aim to breed the leaf-rust resistant wheat cultivar, attempts have been made to transfer the leaf-rust resistance from rye to wheat by wheat-rye chromosome addition and intergeneric translocation. Pollen grains of the disomic addition and young plants at stage of spike differentiation of the monosomic addition were irradiated by x-ray and then used as parents in crosses with wheat cultivar. These X_2 and X_3 plants resistant to leaf-rust races 6A and 21B, respectively were studied cytologically. From them wheat-rye translocations were selected. Further experiments are now being made to select the most desirable translocation. Under normal conditions, the added rye chromosome of the wheat-rye addition does not pair with any wheat chromosome. However, a single plant having 20 bivalents plus one trivalent was discovered in a progeny of monosomic addition line. Results of leaf-rust inoculation and of cytological observation indicated that leaf-rust resistance of this plant has originated from the spontaneous wheat-rye translocation. ST-1 has leaf-rust resistance equivalent to that of the parental addition line and is close to Norin 40, wheat cultivar check, in appearance and vigor, showing the regular chromosome configuration of 21_{II} in meiotic metaphase. (auth)

31256 COMPARATIVE GENETIC EFFECTS OF DIFFERENT PHYSICAL MUTAGENS IN HIGHER PLANTS. Smith, H. H. (Brookhaven National Lab., Upton, N. Y.). pp 75-93 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972).

From Meeting on induced mutations and plant improvement;

The relative genetic effects in higher plants of physical mutagens that produce different spatial distributions of energy in irradiated tissues are reviewed. These are mainly fast neutrons, monoenergetic and mixed spectrum energy neutrons, and radiations produced by accelerated heavy ions. Comparisons are made with sparsely ionizing x- and γ-rays. The average genetic effectiveness from all results combined was greatest (RBE = 71.5) for radiations of dose average linear energy transfer (LET) of 53 to 175 keV/μm. The RBE was reduced to 13 for radiations of lower (7-23 keV/μm) or higher (>175 keV/μm) LET. Track segment analyses of cross-section variations with LET indicate that the target sites for induced genetic change or damage have effective thicknesses of the order of size of DNA molecules. There is little evidence in higher plants for mutagenic specificity among physical mutagens. Control over differential recovery of mutations from high LET radiations remains to be explored. (auth)

31257 EFFICIENCY OF MUTAGENESIS. Gaul, H. (Gesellschaft fuer Strahlenforschung, Cologne); Frimmel, G.; Gichner, T.; Ulonska, E. pp 121-39 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB-297; CONF-701125.

Present knowledge about the efficiency and efficacy of various mutagens and selection methods is summarized; examples are presented from the literature and from published and unpublished results of laboratories. Efficiency is defined as the ratio of chlorophyll mutations to lethality, injury, sterility or chromosome mutations. Efficacy refers to the power of a mutagen to produce useful mutations; the number of selected macro- or micro-mutants is related to the total number of plants which were available for selection. Neutrons have a higher efficiency compared to x- and gamma-rays. Whether or not the efficacy is increased is still an open question. The efficiency of EMS was found in barley to be higher than that of MNH and of ENH. Compared to X-rays, the efficiency of EMS for M_1 lethality in barley appeared to be about five times higher, and for M_1 sterility about four times higher. Pre-soaking of barley seeds resulted in an even higher efficiency of EMS compared with the treatment of dry seeds. Storage or shipping as well as machine-drilling of seeds treated with chemical mutagens requires their redrying. EMS-treated barley seeds can be artificially redried after 18 h or more post-washing at 25°C. Redried seeds with the ordinary moisture content (10 to 14%) may be stored at 0°C or a lower temperature. If the moisture level is 5% or less, these "superdry seeds" can be stored at room temperature. In both instances the originally induced mutation rate and biological damage is maintained without any significant change. In breeding programs, macro-mutants may be utilized in the first place as cross parents, whereas micro-mutants may be used directly. The efficacy of EMS to produce mildew resistance mutants in barley was found to be twice as high as that of X-rays. In contrast to these macro-mutants, micro-mutants occur much more frequently. Following X-irradiation of barley seeds, M_2 plants of normal appearance were taken at random and selection was conducted in subsequent generations between their progenies, namely between M_3 and M_8 strains. Among 1000 M_2 progenies derived from fertile M_1 spikes, there was on the average one with a yield capacity 10% higher than the mother variety. Because of this relatively high frequency, it is recommended that the micro-mutation technique be used for a continuous improvement of newly-introduced varieties and in this way to extend their life-time. (auth)

31258 MUTAGENIC SPECIFICITY IN FLOWERING PLANTS: FACTS AND PROSPECTS. Nilan, R. A. (Washington State Univ., Pullman). pp 141-51 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB-297; CONF-701125.

The directed control of the mutation process has been long desired, in order to be able to induce mutations at specific loci and to produce at will mutants with beneficial value for crop improvement. However, since all genes contain a linear sequence of the same four nucleotides, there are no apparent different sites for mutagen specificity on the intragenic level. In spite of this, some control of the mutation process can be achieved. The paper provides and discusses some examples of differential response of certain loci to chemical and physical mutagens, alteration of the mutation spectrum, and preferential induction of breaks at specific chromosome aberrations. The mechanisms involved are very little understood. Future research might be particularly concerned with intracellular processes that precede or follow the reaction between mutagen and DNA with induction of mutations in active versus inactive genes, with specificity of mutagens on cytoplasmic DNA, and with further development of the techniques of genetic transformation by incorporation of exogenous DNA. (auth)

31259 MUTATION BREEDING FOR YIELD AND KERNEL PERFORMANCE IN SPRING BARLEY. Haensel, H.; Simon, W.; Ehrendorfer, K. (Hochschule fuer Bodenkultur, Vienna). pp 221-35 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB–297; CONF-701125.

An applied micromutation experiment in barley is presented. It was planned as a part of a practical breeding program at a commercial breeding station, with the aim to produce a new variety of brewing barley. One lot of seeds of a cross-bred strain of spring barley was treated with thermal neutrons and in the following year another lot of the same line with EMS. Positive selection for yield and kernel width (grading >2.5 mm) was carried out from M_2 to M_8 with varying selection pressure. The selection response was measured by comparing the M-lines with the untreated strain (control I) and with the four best lines selected out of control I (control II). In early generations selection for yield was more effective after neutron irradiation than after EMS-treatment. In later generations the best lines of both treatments gave similar results surpassing the best line of control II in yield or in "grading" by 3 to 5%. Several of the mutant lines are now being tested in State trials. (auth)

31260 STUDIES OF COMBINED TREATMENT OF ACER NEGUNDO L. SEEDS WITH GROWTH REGULATORS AND MUTAGENS. Privalov, G. F. (Inst. of Cytology and Genetics, Novosibirsk, USSR). pp 265-75 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB–297; CONF-701125.

The application of induced mutagenesis in forest tree breeding is seriously limited by a variety of factors, the main obstacle being the perennial developmental cycle of woody plants. Therefore, it would be of particular importance to have mutations induced preferably in economically-important characters like growth rate. An experiment was started in 1969 to test the hypothesis that active genes are more sensitive to mutagenesis than inactive ones. Various phytohormones supposedly affecting growth rate were applied to seeds in combination with various mutagens. Preliminary data on survival and seedling growth are presented. (auth)

31261 IMPROVEMENT OF VEGETATIVELY PROPAGATED PLANTS BY IONIZING RADIATION. Broertjes, C. (Inst. for Atomic Sciences in Agriculture, Wageningen, Netherlands). pp 293-9 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB–297; CONF-701125.

The main advantage of mutation induction in vegetatively propagated plants is the ability to change one or a few characters of an outstanding cultivar without altering the remaining genotype. It must therefore be considered as an obvious means to perfect the leading products of conventional plant breeding. Special attention is paid to the adventitious bud technique, which makes use of the formation of adventitious buds on isolated leaves. These buds originate from single epidermal cells and thus the consequences of chimera formation are avoided. This has been proven in Achimenes, Streptocarpus, Begonia, Peperomia and Lilium, and is under investigation in a number of other crops. Factors which influence the development of the technique are discussed, such as age, size and part of the leaf, as well as the use of modified leaves. In addition, a few general points are discussed. (auth)

31262 MUTAGENESIS OF A FLUCTUATING CHARACTER: GRAIN DORMANCY IN KRISTINA BARLEY. Gustafsson, A.; Lundqvist, U.; Kucera, J.; Ghatnekar, J. (Inst. of Genetics, Lund, Sweden. Swedish Seed Association, Svaloev). pp 343-8 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB–297; CONF-701125.

Kristina barley is a variety obtained by crossing the x-ray-induced Swedish Mari variety with the Norwegian Domen variety. It gives a high yield, shows good resistance to lodging, and its malting properties are excellent. It has, however, one drawback, its short dormancy period, on account of which it has a marked tendency to germinate on the culm in years when the harvest period is particularly rainy. It has proved possible to reduce this tendency by mutagenic treatment (with radiation and chemical agents) and rigorous selection in special fog chambers over three successive generations (M_2–M_4). Different mutagenic treatments have produced different results as regards the selection efficiency: it was maximal after treatment with EMS, EI and neutrons, and minimal after treatment with MNU and gamma radiation. Prolongation of dormancy is often accompanied by changes in morphology, maturation period (early or late), and other physiological properties. (auth)

31263 COMPARISON BETWEEN EFFECTS OF ETHYL METHANE SULPHONATE AND X-RAYS ON INDUCTION OF MUTATIONS IN CAPSICUM ANNUUM L. Zubrzycki, H. M.; von der Pahlen, A. (Centro de Investigaciones en Ciencias Agronomicas, Castelar, Argentina). pp 387-96 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972). (In Spanish).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB–297; CONF-701125.

Results presented here were obtained from work aiming to produce genetic markers in the chromosomic map of pepper. Treatments were made on seeds of the California Wonder Variety. It was determined that the lethal dose for x-rays was approximately 40 kR, while concentrations of EMS as high as 6×10^{-3}, during 20 h of soaking, did not reach a lethal dose. In order to compare x-rays and EMS as chlorophyll and morphological mutation inductors, M_2 progenies were analyzed. The chemical agent proved to be more efficient and effective in the induction of chlorophyll mutations, while no significant statistical difference in the induction of morphological mutations was observed between the two agents. It was established that the chemical agent provoked more damage on ovule viability than x-rays. Based on the number of chimeras obtained, it was concluded that at the time of the treatment, different meristems which originate fruits, existed in the seed. (auth)

31264 INFORMATION ON THE INDUCTION OF MUTATIONS IN WHEAT BY SEED IRRADIATION. Peixoto Gomes, E. (IPEAS, Rio Grande del Sur, Brazil). pp 443-5 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972). (In Spanish).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB–297; CONF-701125.

In 1960, seeds of three wheat varieties were irradiated with 10 to 30 kR, with the objective of shortening the straw without altering other important characteristics. Short straw mutants have not been found, but mutants with improved resistance to Puccinia graminis tritici have been found. By crossing these resistant mutants, two new wheat strains have been developed which yield 13–15% more than the parent variety IAS 20. This higher yield is probably due to the resistance against the stem rust race 17/63, which is at present very common in the south of Brazil. (auth)

31265 FREQUENCY OF MUTATIONS INDUCED BY GAMMA-RADIATION AND ETHYL METHANE SULPHONATE IN DIFFERENT STAGES OF GERMINATION OF BEAN SEEDS (PHASEOLUS VULGARIS L.). Delgado de la Flor B., F. (Univ. Nacional Tecnica del Altiplano, Puno, Peru). pp 447-51 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972). (In Spanish).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB–297; CONF-701125.

Seeds of two varieties of Phaseolus vulgaris were soaked for 12 to 72 h and were then treated with either 3 kR gamma-rays or with 0.04 M EMS for 6 h at 20°C. The frequency of mutant seedlings was up to 58% after EMS treatment but only up to 21% after gamma-irradiation. No apparent differences were observed between the two varieties. Pre-soaking for 24 h prior to irradiation yielded the highest mutation frequency, whereas no consistent effects of different pre-soaking times between 24 and 72 h were observable with EMS treatment. (auth)

31266 IRRADIATION OF SEEDS OF SORGHUM (SORGHUM VULGARE) AND WHEAT (TRITICUM VULGARE) WITH GAMMA-RAYS. de Alba, G.; Reyes, N.; Hernandes, A. (Instituto Tecnologico y de Estudios Superiores, Monterrey, Mexico). pp 453-5 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972). (In Spanish).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB–297; CONF-701125.

Seeds of Sorghum vulgare and Triticum vulgare were irradiated with gamma-rays in the dose ranges 5 to 25 and 5 to 45 krad respectively. Observations were made on survival, fertility, and various yield characters in order to assess the radiation effects in the M_1 generation. (auth)

31267 ARTIFICIAL INDUCTION OF MUTANTS IN CREOLE POTATO (SOLANUM PHUREJA JUZ. ET BUK.). Gomez Cuervo, P. L. (Univ. del Valle, Cali, Columbia); Estrada Ramos, N. pp 457-69 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972). (In Spanish).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB–297;

Solanum phureja presents some problems to farmers because it lacks a dormancy period, and also to the geneticist and breeder because of its gametophytic self-incompatibility. With the aim of altering both characters, several mutation experiments have been carried out since 1967. Seeds as well as tubers of several clones were irradiated and observations were made on various characters in subsequent generations. Seeds of the different clones showed different radiosensitivity. Phenotypical changes observed in subsequent generations were mostly deleterious. However, one plant was selected, the tubers of which did not sprout for seven months. Another probable mutant gave a fairly high seed setting after pollination within the clone (125 seeds in two berries with about 60% germination). (auth)

31268 DEVELOPMENT OF MALE STERILE SUNFLOWERS. Remussi, C.; Saumell, H.; Vidal, G. (Univ., Buenos Aires). pp 471-4 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972). (In Spanish).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB-297; CONF-701125.

During the spring of 1966 seeds of the sunflower varieties Precoz FAV and Vinnik 1646 were irradiated with gamma-rays from a ^{60}Co source. The doses applied were 6, 12 and 18 kR. Detailed study of these seeds in the following years allowed the identification of male sterile plants, which were crossed with sister lines, lines with high male sterility and commercial varieties. In the sowing of 1969/70, 17 lines were found with high male sterility, one reaching 70%. The male sterile lines originate from one of the inflorescences harvested in 1967 from seeds of the Vinnik variety which received 6 kR. Work to meet the objectives of this experiment will follow during the present year's crop. (auth)

31269 MUTATIONS INDUCED BY IRRADIATION IN THE PEAR PACKHAM'S TRIUMPH. Roby, F. (Instituto Nacional de Tecnologia Agropecuaria, Mendoza, Argentina). pp 475-84 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972). (In Spanish).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB-297; CONF-701125.

In 1959, a given quantity of twigs separated from the mother plant were treated with x-irradiation of 2000, 4000, and 6000 R; the scions were then grafted on French rootstocks. In 1961, the 265 samples thus obtained were planted. When these plants began their fructification, nine mutants could be selected; eight of these arose from the 6000 R irradiation, which, of the three applied doses, was the optimum and the nearest to that considered lethal. The mutants obtained show alterations in the tree, and fundamental changes in the fruits. The undesirable induced changes always surpass the favorable ones. Only one of the mutants obtained deserve our special attention. (auth)

31270 USE OF RADIATION IN BREEDING BANANA (MUSA SAPIENTUM L.). Velez Fortuno, J. (Estacion Experimental Agricola, Rio Piedras, Puerto Rico); Cedeno Maldonado, A. pp 485-9 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972). (In Spanish).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB-297; CONF-701125.

In spite of its high fruit quality, the banana variety Gros Michel has been rapidly replaced by varieties of the Cavendish type, due to its great susceptibility to Fusarium oxysporum cubensis and Cercospora musae. With the aim of developing resistant types with high fruit quality, rhizomes of the variety Gros Michel were treated with 2.5-40 kR gamma-rays. Germination occurred only up to 5 kR, the surviving plants showing some growth reduction but developed flowers and fruits. From the M_2 generation, two mutants were selected, one showing drastic leaf deformations, the other characterized by a more intensive pigmentation and small morphological differences, but comparable to the control in height, vigour and fruit characters. This latter mutant will now be tested for disease resistance. (auth)

31271 SOME BIOLOGICAL EFFECTS OF POST-TREATMENT WITH CYSTEINE ON GAMMA-IRRADIATED RICE SEEDS. Ando, A. (Univ. of Sao Paulo, Piracicaba, Brazil). pp 491-500 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB-297; CONF-701125.

Post-treatment of dry rice seeds with cysteine for 45, 30 and 24 h was compared with gamma-ray treatment. The experimental data and statistical analyses indicate the following: Post-treatment for 45 h had adverse and mutagenic effects under the given conditions. Post-treatment for 30 h showed a protective effect on various R_1 characters and increased chlorophyll mutation frequency in the R_2 though this increase was significant only in the post-treatment after 20 kR of gamma-irradiation. The effect of the post-treatment for 24 h was not significant either in the protection of the R_1 characters or in the increase of chlorophyll mutation frequency. Frequencies of albina, viridis and other types of chlorophyll mutations in the gamma-ray treatment were influenced neither by the post-treatment with cysteine, nor by different times of treatment. Only the post-treatment for 30 h increased the average segregation ratio of the R_1 panicles. (auth)

31272 INVESTIGATION OF A POSSIBLE MUTAGENIC EFFECT OF JUICE FROM IRRADIATED BANANA. Blumenschein, A.; Igreja, M. M.; Valerio, M. A. (Univ. of Sao Paulo, Piracicaba, Brazil). pp 505-10 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972). (In Spanish).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB-297; CONF-701125.

Contradictory reports can be found in the literature regarding the mutagenicity of irradiated food and food products. The paper presents first results from an experiment, where corn seeds were treated with juice from gamma-irradiated bananas. The effects observed from treatment with irradiated juice were inconsistent. (auth)

31273 RESULTS OF BIOLOGICAL INVESTIGATIONS UNDERTAKEN ON THE ZOND-5, ZOND-6, AND ZOND-7 STATIONS. Gazenko, O. G.; Antipov, V. V.; Parfenov, G. P. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 4, 548-54(Jul-Aug 1971).

Translated from Kosm. Issled.; 9: No. 4, 601-9(Jul-Aug 1971).

The principal results of the biological experiments undertaken on the Zond-5, Zond-6, and Zond-7 satellite automatic stations are presented and analyzed. Tortoises (Testudo horsfield), Drosophila, Tradescantia plants, bulbs of the Allium series, dried wheat seeds, various strains of Chlorella, E. coli. and other specimens were used in the experiments. Physiological, morphological, histochemical, genetic, and other procedures were used. The flight conditions were the cause of definite deviations in physiological functions and hereditary structures of a number of the specimens studied. Growth stimulation and development in wheat seeds, barley, and onion plants may be due to their effect, as also the induction in these specimens of chromosome aberrations, and moderate prophage activation in lysogenic bacteria. In both qualitative and quantitative aspects, these changes in the majority of cases did not differ from the deviations recorded in experiments conducted in subradiation belt orbits. (auth)

31274 UV- AND X-RAY RESPONSE OF THE DESMID, MICRASTERIAS DECEMDENTATA. Hart, Ronald Wilson. Urbana, Ill.; Univ. of Illinois (1971). 138p. University Microfilms Order No. 72-12,195.

Thesis.

UV (254 nm) exposure of asynchronous cultures of M. decemdentata resulted in an immediate but temporary suppression of division and a delayed and more protracted division suppression with doses of 135 to 960 ergs/mm^2. Colony-formation (survival) was measured for the same dose range. The D_q value for the dose-survival curve equaled 186 ergs/mm^2 and the extrapolation number (n) approximately 2. Maximum photoreactivable sector for the dose-survival curve equaled 0.52. With maximum photoreactivation the D_q value equaled 270 ergs/mm^2 and the extrapolation number was unchanged. X-irradiation of asynchronous cultures resulted in a nearly immediate suppression of division with doses of from 1.0 to 8.0 kR. Upon resumption of division after doses of 2.0 kR or more, growth was at less than control rate. The duration of division suppression was dose dependent over the dose range studied. Colony-formation (survival) was measured over the same dose range. The D_q value equaled 2.1 kR and the extrapolation number approximately 3. 2.5 kR reduced colony-forming ability by about 50%. Synchronously dividing cultures of Micrasterias decemdentata with an interdivision time of 90 hours were produced by a novel method: Alternation of wavelength (84 hours blue: 12 hours gold) rather than change in the incident quanta. UV-irradiation studies of synchronized cultures revealed that the biphasic division suppression seen in asynchronous cultures was the result of two phases of sensitivity in the cell cycle. The variation in the rate of decay of photoreactivability for the two phases of division suppression directly related to the time of the lesion's expression in the cell cycle. The earlier phase of sensitivity for division suppression does not precisely correlate with the early phase of sensitivity for lethality; the later phases of sensitivity for these two responses are, however, identical. The suggestion is made that the later phase of sensitivity is related to a morphological rather than physiological change, whereas, the earlier periods of sensitivity reflect a physiological change. This study has substantiated the similarity of the radiation response of this alga to that of mammalian cells in culture and argues for its use as a radiobiological tool for additional studies. (Diss. Abstr.)

31275 BREEDING VALUE OF THE X-RAY INDUCED MACRO-MUTANT. III. THE NATURE OF GENETIC VARIABILITY WITHIN MUTATED BACKGROUNDS OF A SINGLE MACRO-MUTANT LOCUS IN CULTIVATED PEANUTS (ARACHIS HYPOGAEA L.). Emery, D. A.; Wynne, J. C.; Rawlings, J. O. (North Carolina State Univ., Raleigh). Radiat. Bot.; 12: No. 1, 7-18(Feb 1972).

The quantitative genetic effects of nine independently mutated backgrounds of the macro-mutant Cup were differentiated and estimates of the additive and additive × additive components of genetic variance were made within three specific Cup backgrounds. Comparable hybrids among control families and common control testers within which the macro-mutants were induced were used to determine residual variance in non-mutated backgrounds. It would appear that the mutated backgrounds of the nine mutant families segregate independent of the macro-mutant locus. A wide range of hybrid means and variances was noted when macro-mutants were involved in the parentage. Differential responses of specific Cup hybrids to changes in location and season also were indicative of the diverse nature of the mutated backgrounds. While the estimates of the components of genetic variance were non-significant statistically, certain specific Cup backgrounds had additive components which were twice that of other Cup or Control backgrounds. Selection potential within backgrounds of independent mutations at the same locus is comparable to that within backgrounds of mutations at different loci. (auth) (UK)

31276 EFFECT OF BUdR ON THE CYCLE OF IRRADIATED AND UNIRRADIATED MERISTEMATIC CELLS OF VICIA FABA. El-Mahdi, Anas M.; Shaeffer, James; Merz, Timothy (Univ. of Virginia, Charlottesville). Radiat. Bot.; 12: No. 1, 1-6(Feb 1972).

The cell cycle time of the meristematic cells of Vicia faba was approximately 20 hr in both the control cells and in the cells treated with TdR (1.6×10^{-5} M) for 24 hr. Cells treated for 24 hr with an equimolar concentration of BUdR showed prolongation of their cell cycle time to about 24 hr. The main detectable change in the cell cycle was the lengthening of the S phase which was increased to 13 hr from 8 hr which was the value for the S phase of the control and TdR-treated cells. BUdR-treated cells exhibited more radiation-induced damage, measured as micronuclei, than control or TdR-treated cells. The x radiosensitization effect was manifested as an increase in the percent of damaged cells but not as an increase in the damage per damaged cell. An attempt to correlate the BUdR-induced changes in the cell cycle with the BUdR-induced increase in radiation response was presented. (auth) (UK)

31277 ESTIMATION OF THE NUMBER OF INITIALS IN GRAIN SORGHUM USING MUTAGENIC TREATMENTS. Sree Ramulu, K.; Sree Rangasamy, S. R. (Agricultural Coll. and Research Inst., Coimbatore, India). Radiat. Bot.; 12: No. 1, 37-43(Feb 1972).

An investigation was carried out to estimate the number of cell initials in the mature embryo of dormant seeds of cultivated grain Sorghum with mutagenic treatments. Dry seeds of S. subglabrascens (Co. 18) were treated with a wide range of physical and chemical mutagens, x-rays, gamma rays, EMS, MMS, DES, NMU, NEU and MNG and also with combination treatments of gamma rays and EMS, MMS and DES. A total of 317 segregating M_1 panicle progenies was studied in the M_2 generation for the ratio of normal to chlorophyll mutant seedlings. The mutant phenotypes are albina, xantha, viridis, chlorina, striata, tigrina, xanthalba and alboviridis. A total of 161 M_1 plant progenies showed a good fit, while the rest of the progenies (156) deviated significantly in both directions from the expected segregation of 3:1. This was interpreted as being due to the origin of M_1 plants from both single cell initials and from multicellular initials following mutagenic treatments, the former segregating for 3:1, while the latter significantly deviating from 3:1. The data on the different mutant phenotypes also revealed the existence of single and multicellular initials in the matured embryo of grain Sorghum. The excess of deficiencies noticed in the mutant phenotypes in the segregating M_1 panicle progenies might be due to a large extent to the chimeric nature of multicellular initials and to a less extent also due to factors operating on gametes and zygotes following mutagenic treatments. An assessment of M_1 fertility as related to the distribution of chi square deviations on 3:1 ratio indicated that the M_1 plants with low fertility are frequently derived from single cell initials and the M_1 plants with high fertility may commonly arise from multicellular initials. (auth) (UK)

31278 EFFECT OF RADIATION ON THE ASPERGILLUS CONIDIUM. I. RADIATION SENSITIVITY AND A GERMINATION INHIBITOR. Scott, Barry R.; Alderson, T.; Papworth, D. G. (Medical Research Council, Harwell, Eng.). Radiat. Bot.; 12: No. 1, 45-50(Feb 1972).

Experimental evidence is reported which suggests that the apparent variability in sensitivity of an aqueous suspension of Aspergillus conidia to a fixed dose of radiation is due to the presence of varying amounts of a germination inhibitor in the conidium and not to a progressive uptake of water. Conditions were also established under which meaningful quantitative data on conidial survival may be obtained. (auth) (UK)

Radiation Effects on Animals (External Source)

Refer also to abstracts 31624 and 32590.

31279 (CERN-71-16(Vol.1 and 2), pp 13-30) RADIATION-INDUCED DISEASE. PROBLEMS OF RESPONSE IN RELATION TO DOSE, DOSE-RATE, AND RADIATION QUALITY. Burch, P. R. J. (Leeds Univ. (England). Dept. of Medical Physics). From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

Two models are proposed to define the biological consequences of small doses of radiation in relation to pathological changes in animals. The roles of dose, dose-rate, and radiation quality in this relationship are discussed. (E.R.B.)

31280 STUDY OF THE ANTINEOPLASTIC EFFECTIVENESS OF SEVERAL DIPHENYLCARBINOL DERIVATIVES. Gilev, Yu. V.; Izmozherov, N. A. (Perm Univ., USSR). Izv. Estestvennonauch. Inst. Perm. Gos. Univ.; 14: No. 10, 121-5(1970). (In Russian).

A study was made of the radioprotective properties of diphenylcarbinol (I) derivatives possessing one to three radicals of $N(CH_3)_2$ and $N(C_2H_5)$ joined to the I molecule in the P position. There is a correlation between the number of donor radicals and the radioprotective effect in going from two radicals to three. (JPRS)

Man

Refer also to abstracts 30986 and 32952.

31281 (ABCC-TR-2-71) LEUKOCYTE RESPONSE TO EXERCISE IN ATOMIC BOMB SURVIVORS, HIROSHIMA. Belsky, Joseph L.; Ohashi, Toshiro; Robertson, Thomas L.; Taniguchi, Banri; Ishimaru, Toranosuke (Atomic Bomb Casulaty Commission, Hiroshima, Nagasaki (Japan)). [1971]. 18p. Dep. NTIS.

A total of 254 male and female subjects of the ABCC-JNIH Adult Health Study population were examined for changes in circulating leukocytes before and after moderate exercise. The exercise was an augmented two-step test used routinely for cardiac evaluation. None had post-exercise ischemic electrocardiogram changes. An immediate increase in mean pulse rate (70.2 to 120.6/min) was obtained. The group showed increased means for total white blood cell count, mature granulocytes, and lymphocytes by 33%, 20%, and 60% respectively (for each, $P < .001$). There was no relation to A-bomb radiation dose when pre- and post-exercise counts were compared. For granulocytes there was good correlation of incremental change with initial granulocyte and lymphocyte counts and age, but not with change in pulse or radiation dose. This test measures circulating cells rather than bone marrow function. The observation that the circulating granulocyte pool is similarly reactive to exercise stimulation in A-bomb survivors and controls does not rule out radiation-induced changes in the bone marrow. Changes in lymphocytes, while striking, are difficult to interpret because of their extramedullary functions. Comparison with other stimulating tests are discussed. (auth)

31282 (ABCC-TR-7-71) CANCER IN JAPANESE EXPOSED AS CHILDREN TO THE ATOMIC BOMBS, 1950-69. HIROSHIMA AND NAGASAKI. Jablon, Seymour; Tachikawa, Kiyoshi; Belsky, Joseph L.; Steer, Arthur (Atomic Bomb Casualty Commission, Hiroshima (Japan). Atomic Bomb Casualty Commission, Nagasaki (Japan)). 25 Mar 1971. 20p. (In English and Japanese). Dep. NTIS.

The occurrence of cancer was studied in 20,609 persons, members of the JNIH-ABCC Life Span Study sample who were less than 10 years old at the time of the atomic bombs in Hiroshima and

Nagasaki. In addition to the well-known large increase in the risk of leukemia among the irradiated survivors, it has become apparent that, since about 1960, those who received relatively large doses (more than 100 rad) have had cancer rates several times those among low dose survivors or those who were not in the cities. Although the number of cancers that have been detected thus far is not very large, the reality of the effect is attested, not only by formal statistical significance tests, but by consistency between death certificate and other notifications. (auth)

31283 (ABCC-TR-16-70) ESTIMATION OF GAMMA-RAY DOSE FROM NEUTRON-INDUCED RADIOACTIVITY IN HIROSHIMA AND NAGASAKI. Hashizume, Tadashi; Maruyama, Takashi; Kumamoto, Yoshikazu; Kato, Yoshio; Kawamura, Shoichi (Atomic Bomb Casualty Commission, Hiroshima (Japan). Atomic Bomb Casualty Commission, Nagasaki (Japan)). 1 Jul 1970. 20p. (In English and Japanese). Dep. NTIS.

The gamma-ray dose from the radioactivity induced in soil and building materials by neutrons was estimated on the basis of the experimental data. The chemical compositions of soil and building materials collected from Hiroshima and Nagasaki were determined by an activation analysis. It was found that ^{24}Na and ^{56}Mn contributed mainly to the gamma-ray dose from the radioactivity induced in soil. The dose received by a person who entered the hypocenter area in Hiroshima one day after the bombing and remained there 8 hr would have been 3 rads. The doses at distances of 500 m and 1000 m from the hypocenter in Hiroshima were 18% and 0.07% respectively, of that at the hypocenter. The accumulated gamma-ray dose from immediately after the explosion of the A-bombs to infinity was about 80 rads at the hypocenter in Hiroshima, and about 30 rads in Nagasaki. (auth)

31284 (ABCC-TR-27-69) STUDY OF APLASTIC ANEMIA IN AN AUTOPSY SERIES, 1949–67, HIROSHIMA–NAGASAKI, WITH SPECIAL REFERENCE TO ATOMIC BOMB SURVIVORS. Kirshbaum, Jack D.; Matsuo, Takeshi; Sato, Kazuo; Ichimaru, Michito; Tsuchimoto, Taiso; Ishimaru, Toranosuke (Atomic Bomb Casualty Commission, Hiroshima, Nagasaki (Japan)). 14p. Dep. NTIS.

Material from the ABCC autopsy files of Nagasaki (2941 cases) and Hiroshima (3836 cases) was examined with the hope of determining the prevalence of aplastic anemia among A-bomb survivors as a late effect of ionizing radiation. The criteria used for the autopsy diagnosis of aplastic anemia included hypoplastic or aplastic bone marrow and clinical findings of pancytopenia. Cases with tumor metastatic to bone marrow, leukemia, and myelofibrosis were excluded. A total of 45 cases were confirmed by both pathologists and hematologists, 19 cases in Hiroshima and 26 cases in Nagasaki. There were 7 males and 12 females in Hiroshima and 15 males and 11 females in Nagasaki. The prevalence rate of aplastic anemia was higher in the younger age groups. There were 17 cases in A-bomb survivors of which 7 received more than 1 rad of radiation. The number of cases was too small to make any final conclusion as to the relationship of radiation exposure and aplastic anemia, since there were no significant differences in the histological changes in the bone marrow or clinical findings characteristic of aplastic anemia in exposed and nonexposed subjects. (auth)

31285 (BNWL-SA-4121) IN-PHANTOM DOSIMETRY OF PROTOTYPIC PLUTONIUM CIRCULATORY SUPPORT HEAT SOURCES. Cross, F. T.; Sheppard, J. C. (Battelle Pacific Northwest Labs., Richland, Wash.). Feb 1972. Contract AT-(45-1)-1830. 20p. (CONF-720411-3). Dep. NTIS.

From Symposium on dosimetry techniques applied to agriculture, industry, biology, and medicine; Vienna, Austria (17 Apr 1972).

Tissue equivalent human phantoms were used to measure the radiation dose rate to adjacent tissues from a radioisotope heat source used to power blood circulatory support systems. A 30W Pu metal source containing about 900 Ci ^{238}Pu and 0.58 ppm ^{236}Pu was used in the heat source system. Photon dose rates were measured with small thermoluminescent dosimeters and neutron dose rates were measured with small tissue-equivalent proportional detectors. A computer code (QAD-P5A) was used for computations of the radiation dose rate. Results indicated that the use of this mechanical heart over a long period of time would not exceed the radiation dose rates established as acceptable for occupational exposure. (C.H.)

31286 (CERN-71-16(Vol.1 and 2), pp 167-73) EFFECTIVE DOSE AND SEVERAL FACTORS OF ITS IDENTIFICATION. ASSESSMENT OF RADIATION HAZARD IN SPACE FLIGHTS. Farber, Yu. V.; Grigor'ev, Yu. G.; Tabakova, L. A.; Gorlov, V. G.

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

Experimental results show that in evaluating the radiation hazards of space flight the effective dose must be taken into consideration. Otherwise, in repeated exposures of the body to ionizing radiations, over-estimation of the expected radiobiological effects could occur. It was established that with increased time between radiation exposures, the value of the effective dose decreases. This relationship is represented as an attenuating oscillatory process characteristic of biological mechanisms based on an inverse negative relation. The process of post-irradiation recovery varies with time in an oscillatory manner and at certain times after exposure, extreme values may be observed. (E.R.B.)

31287 (CERN-71-16(Vol.1 and 2), pp 207-19) EFFECT OF LATERAL SCATTERING ON ABSORBED DOSE FROM 400-MeV NEUTRONS AND PROTONS. Wright, H. A.; Hamm, R. N.; Turner, J. E. (Oak Ridge National Lab., Tenn.).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

In this investigation, two types of calculations were performed to determine the effects of lateral scattering of 400 MeV proton and neutron beams by a water absorber. In one type, the particles were incident along the axis of a cylindrical water phantom of radius 25 cm. The energy per incident particle that would be measured by circular detectors of various radii was calculated as a function of distance behind the end of the cylinder on which the particles were incident. Also, the energy that would be measured with a detector of 25 cm radius (an entire cross section of the phantom) is compared with the case for an infinite slab. In the second type of calculation, the particles were incident uniformly over one end of a cylindrical water phantom of radius 15 cm. The dose per incident particle per cm^2 that would be measured by detectors of various sizes was calculated as a function of depth behind the end of the phantom. (auth)

31288 (CERN-71-16(Vol.1 and 2), pp 246-59) CALCULATION OF THE L.E.T. DISTRIBUTION FROM NEGATIVE PI MESONS IN TISSUE. Holt, P. D. (Atomic Energy Research Establishment, Harwell (England)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The linear energy transfer (LET) distribution from π^- mesons in muscle tissues was calculated. The relative biological effectiveness at 13.0, 15.0, and 17.0 cm was calculated for aerobic and anaerobic conditions, and the oxygen enhancement ratios at each distance were also calculated. It is concluded that from the standpoint of LET, stopping π^- mesons would not be as desirable as 14 MeV neutrons for radiotherapy. (E.R.B.)

31289 (CERN-71-16(Vol.1 and 2), pp 300-27) NEUTRON DEPTH DOSE IN MAN AND CORRESPONDING QUALITY FACTORS. SOME HERETICAL CONSIDERATIONS. Pretre, S. (Forschungsinstitut fuer Militaerische Bautechnik, Zurich (Switzerland)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

On the basis of tissue-equivalent phantom measurements, the depth dose distribution of neutrons of various energies was calculated. The corresponding quality factors were also derived. A detailed series of definitions for each factor in the calculations are presented. (E.R.B.)

31290 (CERN-71-16(Vol.1 and 2), pp 328-43) HIGH-ENERGY NUCLEON TISSUE DOSES. Dmitrievskii, I. M.; Kabakov, Ya. I.; Potemkin, E. L.; Frolov, V. V. (Moskovskii Inzhenerno-Fizicheskii Institut (USSR)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The absorbed dose and dose equivalent distributions for high-energy nucleons (0.4, 0.6, 1, 2, 3, 5, 10, 20, and 30 GeV) incident on a tissue-equivalent slab phantom 30 cm thick and infinite in lateral extent were calculated. From the calculations, it was determined that the absorbed and equivalent doses increase with depth in the slab for both the neutrons and the protons. The most rapid dose buildup was observed near the surface of the slab (5 to 10 cm). Quality factor calculated for nucleon energies from 3 to 30 GeV was 2 for neutrons and 1.9 for protons. (E.R.B.)

31291 (CERN-71-16(Vol.1 and 2), pp 344-59) DEPTH-DOSE EXPERIMENTS WITH MONO-DIRECTIONAL 14-MeV NEUTRONS IN A LOW SCATTER ENVIRONMENT. Fuller, E. W.; Eustace, R. C. (Atomic Weapons Research Establishment, Aldermaston (England)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

Investigations were conducted to investigate the depth dose distribution of mono-directional 14 MeV neutrons in a low-scatter environment. In the experiments, tissue-equivalent phantoms of circular or elliptical cross section were suspended 30 m above the ground and at least 30 m from the neutron source in order to ensure low scatter, low divergence conditions of irradiation. The neutron source was mounted on a 500 m tower. The HENRE facilities were used for the investigations. The measurements were considered to provide useful support for the ORNL calculations of the mid-line dose distribution. (E.R.B.)

31292 (CERN-71-16(Vol.1 and 2), pp 360-70) METHODS OF REMMETRY IN THE FIELDS OF MIXED RADIATION. Keirim-Markus, I. B.; Markelov, V. V.; Chernykh, I. V. (Ministerstvo Zdravookhraneniya SSSR, Moscow).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

Methods are proposed for measuring the average radiation quality factor and for determining the radiation dose spectrum based on the irradiation of tissue-equivalent phantoms with accelerator proton beams. Phantom measurements were made for 510, 240, and 125 MeV protons. The results obtained using the proposed methods are in good agreement with the values measured at the same points in the phantoms using tissue-equivalent ionization chambers. (E.R.B.)

31293 (CERN-71-16(Vol.1 and 2), pp 524-56) RADIOLOGICAL PROTECTION IN SST AIRCRAFT. Fuller, E. W.; Day, B. (Atomic Weapons Research Establishment, Aldermaston (England)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The radiological environment of supersonic transport aircraft, which will operate at altitudes where the dose equivalent rates for cosmic radiation (galactic and solar) are greater than those encountered by subsonic aircraft, was studied and the instrumentation required for monitoring this environment was developed. The study was approached in terms of the conventional concepts of radiological protection, rather than those of cosmic ray physics or radiobiology. Studies conducted at appropriate altitudes indicated that the galactic component of the cosmic radiation would be considerably less than accepted maximum permissible levels, but that the solar component might cause levels in excess of these permitted levels. An instrument was developed to measure the dose equivalent rate from the solar component at the cruising altitude for supersonic transport aircraft. (E.R.B.)

31294 (CERN-71-16(Vol.1 and 2), pp 557-72) EVALUATION OF THE DENSITY OF COSMIC RAY ENDERS IN HUMAN TISSUE FROM SOLAR MINIMUM TO MAXIMUM AT THE LEVEL OF SST FLIGHT. Fukui, K. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.); Young, P. S. (Mississippi State Univ., State College).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

A study was conducted to evaluate the density of heavy thindown tracks observed at the level of supersonic transport flight, and the change of the density from solar minimum period to solar maximum period. The number of thindown tracks in human tissues near the body surface at the level of supersonic transport flight near the pole is estimated. (E.R.B.)

31295 NUCLEAR TECHNIQUES. IV. INFLUENCE OF IONIZING RADIATION ON MAN. Nooteboom-Beekman, Z. M. Polytech. Tijdschr., Procestech.; 26: 309-12(14 Apr 1971). (In Dutch).

This part of the article series deals with the sources of ionizing radiation, the effect of radiation on man (inner and external radiation), the maximum permissible dosages and concentrations and the legal control of radiation protection in Holland. (auth) (Netherlands)

31296 DELAYED RADIATION MYELOPATHY IN MAN. REPORT OF TWELVE NECROPSY CASES. Jellinger, K.; Strum, K. W. (Univ., Vienna. Univ., Munich). J. Neurol. Sci.; 14: No. 4, 389-408(Dec 1971).

The necropsy findings in 12 adult humans with myelopathy following conventional x-ray, ^{60}Co or betatron radiotherapy of cervical and mediastinal tumors are reported. The latencies varied from 3 to 41 months, survival time after the onset of neurological defects ranged from 3 weeks to 75 months. No relations of latency and clinical course to calculated maximum—minimum spinal cord doses could be established. Time-dose considerations showed that the average cord doses in all except 2 cases were above suggested tolerance levels. Lesions occurring in 2 patients 26 weeks and 12 months after irradiation took the form of spongy demyelination and astroglial reaction with loss of oligodendroglia in the absence of definite vascular lesions. Later stages of delayed radiation myelopathy were largely consistent with those of earlier reports. Telangiectasias and relative preservation of nerve cells were constant findings. One case showed flaky demyelination of thoracic nerve roots associated with almost complete transverse necrosis of the dorsal spinal cord. The pathogenesis of delayed radiation lesions of the spinal cord is discussed in relation to recent experimental data. Biophysically induced lesions of the oligodendroglia and damage to the vascular endothelium together with secondary permeability disorders of the blood-brain barrier are suggested as the most important factors. The causes of individual susceptibility to radiation are still unknown. No relation between hypertension and regional selectivity or development of delayed radiation damage to the spinal cord was noted in the present and comparable human case series. The concepts of threshold levels of the human spinal cord in relation to radiation damage are not yet clearly defined. (auth)

31297 IMPLANTATION OF ^{192}Ir RADIATION SOURCES AND ITS DOSAGE DISTRIBUTION. MATHEMATICAL MODEL AND DOSIMETRIC CHECKING. Fossati, F.; Tosi, G. (Ospedale Maggiore, Milan). Strahlentherapie; 142: No. 6, 686-94(Dec 1971). (In German).

The interstitial therapy of small tumors (i.e. intraocular malignant tumors) may be favorably carried out by ball or linear sources of ^{192}Ir. Some mathematical methods for calculation of the dose distribution of such a source are described. It is possible to calculate the absorbed dose in any point of the implanted volume. A dosage calculation apparatus is described that allows an experimental checking of the calculated values. (auth)

31298 TWO MAJOR HISTOLOGICAL TYPES OF GASTRIC CARCINOMA AMONG THE FIXED POPULATION OF HIROSHIMA AND NAGASAKI. Yamamoto, Tsutomu; Kato, Hiroo (National Inst. of Health, Tokyo. Atomic Bomb Casualty Commission, Hiroshima. Atomic Bomb Casualty Commission, Nagasaki). Gann; 62: No. 5, 381-7(Oct 1971).

Lauren's histological classification of gastric carcinoma based on the presence of either intestinal or diffuse type was applied to autopsy cases in the fixed population sample of Hiroshima and Nagasaki for 1961 to 1969. The intestinal type was chiefly seen in older persons and the diffuse type was more frequent in younger persons, especially in women. The ratio of the intestinal type to the diffuse type in Japan was compared with this ratio for high or risk areas in other countries. The trend of this ratio was similar to that in other cities. There was no statistically significant relation between the occurrence of either type of gastric carcinoma and radiation exposure. (auth)

31299 DEPHOSPHORYLATION OF SYNKAVIT AND ANALOGUES BY NORMAL AND NEOPLASTIC TISSUES. Srinivasan, N. G.; Chandramouli, K.; Sivaramakrishnan, V. M. (Cancer Inst., Madras). pp 403-13 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

The enzymatic dephosphorylation of Synkavit (2-methyl 1,4-naphthohydroquinone diphosphate) and closely related compounds by normal and tumor tissues has been studied. Human tumor tissues as well as rat fibrosarcoma have been found to dephosphorylate Synkavit actively, faster than the adjoining normal tissues. Among Synkavit and the related compounds, those compounds which are dephosphorylated actively have been found to be good radiation sensitizers and vice versa. These data strongly suggest that dephosphorylation of these compounds is a prerequisite for their radiation sensitizing action. Dephosphorylation of Synkavit gives rise to a series of non-phosphorus containing fluorescent metabolites. Dephosphorylation carried out for varying lengths of time provides important clues for the sequence of reactions. One of the end products is most probably menaphthone; and radiation sensitization achieved by removal of sulfhydryl groups. (auth)

31300 CYTOGENETIC CHANGES INDUCED BY IONIZING RADIATION IN MAN. Todorov, S.; Ivanov, B. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 13-20(1967).

Research in human cytogenetics is briefly reviewed. The cytogenetic effects of ionizing radiations in man are also reviewed and the impact of cytogenetic methods on the establishment of health and safety measures in the expanding atomic energy industry is discussed. (E.R.B.)

31301 BINDING OF RADIOPROTECTIVE AET TO PROTEINS. Horvath, Magdolna; Foris, Gabriella; Csagoly, E.; Sztanyik, L.; Dalos, B. (National Research Inst. for Radiobiology and Radiohygiene, Budapest. State Inst. of Pharmacy, Budapest). Int. J. Radiat. Biol.; 21: No. 3, 263-78(Mar 1972).

Experiments were performed in vitro to reveal the mechanism of possible mixed disulphide formation between various proteins and AET. The following proteins were examined: albumin, fibrinogen, oxyhaemoglobin, haemoglobin, insulin, trypsin, and ribonuclease. Physico-chemical changes, such as absorption spectra, electrophoretic mobility and polarographic behavior of biologically active proteins such as insulin and oxyhaemoglobin were examined as well as changes in biological activity. Only the –SH proteins were able to form mixed disulphides with AET. The exception was insulin at alkaline pH where the subunits of the molecule were associated into polymers of high molecular weight. (UK)

31302 QUANTITATIVE EXPRESSIONS OF RADIATION EFFECTS ON HUMAN CHROMOSOMES. Biagini, C.; Brancadoro, P.; Siciliano, A. (Univ., Rome). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 45-58(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Following partial-body gamma therapy, the effects of radiation on leukocyte chromosomes were studied. A review is presented of the results obtained, and the possibility of obtaining quantitative expressions of the radiation effects is criticized. A direct relationship was found between absorbed dose and radioinduced dicentric and ring chromosomes and radioinduced chromosome breaks in patients examined 24 to 72 hrs after a single exposure, and dose-effect coefficients are given. For other types of abnormalities higher mean values were obtained in irradiated subjects compared with controls. Some of the sources of variability affecting the results are surveyed. Data related to chromosome aberrations in control subjects are given in detail and the significance of the diagnostic exposure is discussed. The criteria for selecting significant effects of the absorbed dose are discussed with regard to the influence of physical and biological factors. (H.L.W.)

31303 CLINICAL APPLICATIONS OF RADIATION RESEARCH ON CHROMOSOMES. Lenzi, M.; Salvolini, U. (Univ., Modena, Italy). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 59-82(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Of the techniques used in experimental research laboratories in human cytogenetics and culture methods of human somatic cells, the one that is stressed for use in clinical laboratories is the use of peripheral leukocytes. This procedure is available as a clinical test. The following applications of cytogenetic analyses of leukocytes are discussed: use as biological dosimeters in radiography and nuclear medicine; use as tests in radiotherapy for more rational formulation of dose fractionation methods and radiochemical procedures; and use for practical studies on the problem of radiation carcinogenesis. The limitations of the method and areas requiring further research are outlined. (H.L.W.)

31304 EFFECTS OF IONIZING RADIATIONS ON HUMAN KIDNEY. Bono, F. (Univ., Bologna); Bonomini, V.; Capelli, A.; (and others). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 109-66 (1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Studies were made on early and late radiation damage to the kidney using a large number of clinical and experimental cases. Early renal damage (less than three months) was not evident clinically. Electron microscope examinations revealed a slight damage to the glomeruli. Little deviation of normal renal blood flow and glomerular filtration was observed. Histological and ultrastructural studies showed typical interstitial sclerotic lesions the severity of which was related to dose. (H.L.W.)

31305 RISKS OF CARCINOGENESIS AND LEUKAEMOGENESIS IN MAN. Sella, F. (United Nations, New York). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 175-90(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

The estimates of the risks of radioinduced human malignancies currently available are based on the assumption that the frequency of induced leukemia bears a relationship of simple proportionality to the dose received. This has a corollary that the spatial distribution of the doses in tissues is irrelevant for estimating risks, so that only average tissue doses need to be considered. Linearity, however, is difficult to defend on theoretical grounds and can only be accepted as an empirical relationship valid within the range and under the circumstances in which it is observed. Only for leukemia can the relationship be established with some degree of confidence within a fairly wide range, between 100 and a few hundred rads. The relationship is based on the observation of the incidence of leukemia in survivors of atomic bombings as a function of rather uncertain estimates of the doses received, and is borne out by the fact that the observed number of leukemias in various cases of partial irradiation of the bone marrow is roughly that expected, on the basis of the linear relationship from the average marrow doses. That things may, however, be more complex than implied by simple linearity is shown by the failure to detect increased incidence of leukemia in a recent survey of women irradiated for cervical carcinoma. Nothing is known about the rates of incidence of leukemia in the adult after irradiation at doses in the diagnostic range, nor about the validity of extrapolating to that range the values obtained at higher doses. It is generally accepted, however, that rates of induction per unit dose are unlikely to be higher at low than at high doses. While irradiation of children appears to entail risks of the same order as that of adults, higher risks seem to be involved in pre-natal irradiation at doses of the order of a few rad. Quantitative estimates of general validity are difficult to obtain because of uncertainty of the dosimetry and because the surveys of prenatally irradiated children carried out so far were retrospective and only yielded estimates of the induced frequency relative to the local spontaneous incidence. Since the spontaneous incidence varies from area to area and shows pronounced time trends, there is no simple way of predicting the risks in areas and at times different from those where they have been established. Thyroid cancer is the second best known radiation-induced malignancy. Here the range of doses after which it has been observed is narrower than for leukemia and linearity is correspondingly less well-established, while indirect criteria based on partial irradiation cannot be applied. However, although linearity is sometimes assumed for the sake of simplicity and because it has proved useful in the case of leukemia, in general data are inadequate to establish dose-effect relationship, much less to test linearity. (auth)

31306 RISK OF RADIATION DAMAGE TO THE EMBRYO AND THE FIRST-GENERATION GENETIC RISK. Metalli, P. (CNEN, Rome). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 191-229(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

The aim of the present review paper was to compare the current recommendations of radiation protection with the qualitative and quantitative data now available on the effects of radiation on the embryo and on the genetic material. ICRP Publications no. 8 and 9, and the UN Reports on the effects of atomic radiation, were the main sources of information. After some introductory remarks on general problems, radiation effects on the embryo were described in a schematic manner, and it has been emphasized that although extensive information was collected from experimental animals, numerical risk estimates for this type of radiation damage are not yet available for man. Specific ICRP recommendations for maximum permissible exposures to the abdomen of pregnant women, or during the child-bearing age, are therefore based primarily on general considerations, and should be taken only as "reasonable limits." With respect to the first-generation risk, several pertinent data on the spontaneous rate of mutation in man and on the rate of induction per unit dose in experimental animals were collected and reviewed. Some examples of the numerical estimates from both ICRP and UN Reports were illustrated. Limitations and uncertainties associated with the calculations have been emphasized, due mainly to the paucity of the data and to a few basic assumptions that must be made in order to arrive at the final risk estimates. Finally, some recent experimental data and new scientific contributions of relevance to problems of radiation protection were reported. (auth)

31307 RADIATION RISK AND MAXIMUM PERMISSIBLE DOSES. Polvani, C. (CNEN, Rome). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 230-69(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

International recommendations and national regulations that fix the values of maximum permissible radiation dose (MPD) for the whole body and for single parts of the body, for organs, and for tissues of man are discussed. The rational ground of the choice for such values should be found in the evaluation of severe risks which can possibly follow the irradiation of organs. It should be assumed that the irradiation of the whole body or of a given organ with its relative MPD, could cause a risk of severe events which is not very dissimilar from that connected to the irradiation of another organ with the MPD established for it. At present the scientific knowledge is inadequate to compare doses to different tissues that may be associated with equal likelihoods of consequences of comparable importance, but it is also true that we are beginning to be able to evaluate the risk related to the irradiation of various single organs and tissues in the body and also to the irradiation of some of their components. The ratios which should exist between MPD for the whole body, for the red bone marrow, for the thyroid, or for another single sensitive organ in the body could be therefore derived. Other considerations could be made if, instead of unequal doses to various organs or parts of the body, the non-uniform spatial distribution of the dose within a single organ or tissue is considered. (auth)

31308 CHROMOSOME STUDY IN SUBJECTS EXPOSED TO IONIZING RADIATIONS. Barbaini, S.; Caldarini, G. (Ospedale di Circolo, Milan). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 280-96(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Cytogenetic research included analysis of structural and numerical changes in chromosomes in various pathological conditions. Fifty members of the radiology staff were selected for cytogenetic analysis, and chromosome aberrations were compared with those of 50 control subjects and with those of subjects exposed to benzol, LSD, and other drugs. (H.L.W.)

31309 BIORHYTHMICAL ASPECTS OF RENAL RADIOPATHOLOGY. Bistolfi, F. (Univ., Genoa). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 357-60(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Differences were observed between frequency of histological changes and relative rareness of clinical syndromes. It is suggested that this phenomenon can be interpreted by two factors: a macroscopic volume factor depending on radiation technique and a microscopic volume factor in relation to biorhythmic activity. It is thought that radiation injuries to the kidney are related to a rhythmical radiosensitivity in time and place. Glomerular-arterial biorhythms in relation to extracellular oxygen tension are emphasized. (H.L.W.)

31310 RENAL FUNCTION IN PELVIS IRRADIATED PATIENTS. Pisani, G.; Nuvolone, U. (Ospedale Maggiore, Novara, Italy). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 390-4(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Anatomical and physiological changes in the urinary system were observed in patients following pelvic irradiation using interstitial radium-226 γ, and external x radiation and ^{60}Co γ therapy. The results indicated that functional changes were very slight during the early post-radiation period; alterations were more pronounced during later periods following irradiation. (H.L.W.)

31311 BIOLOGICAL AND MEDICO-LEGAL CONCEPT OF DAMAGE FROM IONIZING RADIATIONS. Biagini, C.; de Vincentiis, G.; Strambi, E. (Centro Studi Nucleari, Rome). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 430-7(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Problems of physicians who must give opinions for legal purposes as to radiation injuries sustained by humans exposed during accidents or as a result of medical procedures are reviewed. It is pointed out that for medico-legal purposes not only the extent of the damage already incurred but the potential damage that may not be obvious until a future date must be considered. (C.H.)

31312 INVESTIGATION ON A POSSIBLE GENETICALLY SIGNIFICANT GONAD DOSE ENSUING FROM DIAGNOSTIC USE OF X-RAYS IN NOVARA PROVINCE POPULATION. Catania, E.; Savino, G.; Sorrentino, R. (Ospedale Maggiore, Novara, Italy). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 455-64(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

An evaluation was made of the genetically significant gonad dose resulting from the diagnostic use of x rays in Novara Provine, Italy during 1966. The evaluation was made according to the method recommended by the United Nations Scientific Committee on radiation effects. Sample data collected in a few institutions was extrapolated to the total number of examinations. Examinations made between 1963 and 1967 were also considered. Results indicated that the average radiation dose per individual was 23,176 mrem; the percentage of examinations per inhabitant was 34%. It is thought that the data will be useful for evaluating genetically significant radiation doses during the diagnostic use of x rays. (H.L.W.)

31313 LYMPHOCYTIC DAMAGE IN IRRADIATED SUBJECTS. METABOLICAL ASPECTS OF REACTIVITY TO PHYTOHEMAGGLUTININ OF IN VITRO CULTIVATED LYMPHOCYTE. Dragoni, G.; Bertoli, M. A. (Univ., Milan. Univ., Pavia, Italy). Med. Nucl.-Radiobiol. Lat.; Suppl.; No. 3, 465-90(1968). (In Italian).

From ninth national conference of the Italian association of medical radiobiology; Varese, Italy (20 Sep 1968).

Lymphocytes from normal subjects, and from patients with hyperthyroidism or malignant epithelial tumors given radiotherapy were cultivated in vitro and treated with PHA. An analysis was made of the degree and repair of radiation damage. It was found that the response of lymphocytes to PHA was reduced after radiotherapy according to the dose and type of radiation. The RNA and DNA contents of the lymphocytes from irradiated and non-irradiated subjects were compared. A relationship between RNA content and blast formation of radiation-damaged lymphocytes was noted, and a marked reduction of DNA synthesis was noted in lymphocytes damaged by radiation. (H.L.W.)

31314 WOMEN'S PROFESSIONAL EXPOSURE TO IONIZING RADIATION AND PARTICULAR PROBLEMS OF RADIOPROTECTION. Ghislandi, E.; Bazzano, E. (CISE, Milan). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 510-18(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

The problem of the exposure of working women to ionizing radiations is considered within the framework of Italian laws and taking into account the recommendations of ICRP adopted in September 1965. A short review of regulations protecting working women in general in Italy is given and the contributions of industrial medicine to the study of physiopathology of working women is mentioned. An approximate numerical evaluation is given of the female nuclear labor force in industry, scientific research, and medicine in Italy. Considering in detail regulations and recommendations of radioprotection proposed in national and international field for women, the importance is emphasized of adopting the maximum permissible doses suggested by ICRP, corresponding to 1.3 rems over a period of 13 weeks at the abdomen, for the professional exposure of females during the whole reproductive age. In this way protection is assured for the embryo when pregnancy is still unknown to the mother herself and thus avoiding a drastic and anachronistic exclusion of women from work with radiations during the reproductive age. (auth)

31315 BIOLOGICAL EFFECTS OF CONTINUOUS EXPOSURE TO LITTLE DOSES OF IONIZING RADIATIONS OF NATURAL ORIGIN. Gianferrari, L.; Gualandri, V.; Campana, C. (Univ., Turin). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 575-94(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

A comparison was made of neonatal and perinatal mortality, the ratio of sexes to birth, and mortality caused by neoplasms for two human population groups. One population lived in a region of high natural radioactivity (the Cervo Valley near Biella) and the other lived in a region of low background radioactivity (the Mosso Valley). A statistical analysis of the data showed a meaningful increase of mortality caused by neoplasms in the population living in the region with high natural background radioactivity. (C.H.)

31316 DOSIMETRY IN INTERSTITIAL ^{192}Ir RADIOTHERAPY. Volterrani, Fabio (Univ., Milan). Radiol. Med.; 57: No. 5, 354-60(May 1971). (In Italian).

A table showing doses absorbed over 1 hr at 2 mm step distances on a straight line at right angles to the midpoint of rectilinear ^{192}Ir sources of different length and with linear activity of 1 mCi/cm is presented and its use in interstitial ^{192}Ir radiotherapy dosimetry is discussed. (auth)

31317 DETERMINATION OF THE SUPERFICIAL DOSE DISTRIBUTION AND ITS SIGNIFICANCE FOR THE INTEGRAL DOSE CALCULATIONS. Bojtor, I.; Varteresz, V.; Illes, A.; Koczkas, Gy.; Luzsa, Gy. Izotoptechnika; 14: No. 10, 458-65(Oct 1971). (In Hungarian).

During x-ray diagnostics, the body surface is exposed to nonuniformly distributed x rays. This should be taken into account when calculating integral dose. (auth)

Vertebrates

31318 (CERN-71-16(Vol.1 and 2), pp 31-43) RBE FOR LATE SOMATIC EFFECTS IN MICE IRRADIATED WITH 60-MeV PROTONS RELATIVE TO X RAYS. Darden, E. B. Jr.; Clapp, N. K.; Bender, R. S.; Jernigan, M. C.; Upton, A. C. (Oak Ridge National Lab., Tenn.).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The RBE of energetic protons, relative to x rays, for the induction of somatic effects in mammals following whole-body exposure was studied. The somatic effects investigated included effects on longevity and on the incidence of neoplastic diseases. Mice were used in the studies indicated. It was concluded that medium energy protons were no more effective, probably less effective, than conventional x rays for the induction of late somatic effects. (E.R.B.)

31319 (CERN-71-16(Vol.1 and 2), pp 44-51) CYTOGENETICAL ANALYSIS OF CORNEAL AND INTESTINAL EPITHELIUM DAMAGE AFTER IRRADIATION WITH HIGH ENERGY PROTONS. Mastryukova, V. M.; Strzhizhovskii, A. D. (Ministerstvo Zdravookhraneniya SSSR, Moscow. Institut Mediko-Biologicheskikh Problem).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The effects of protons on mitotic index and the frequency of aberrant mitoses in corneal and intestinal epithelial cells of mice were studied. The mice were exposed to 50 to 630 MeV protons in doses of 200 to 750 rads. RBE values for the high energy protons were equal to or somewhat less than one. (E.R.B.)

31320 (CERN-71-16(Vol.1 and 2), pp 52-61) LATE EFFECTS OF 2.2-GeV PROTONS ON THE CENTRAL NERVOUS SYSTEM. Lippincott, Stuart W.; Calvo, Wenceslao (Medical Coll. of Virginia, Richmond. Ulm Univ. (West Germany). Brookhaven National Lab., Upton, N. Y.).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The late effects, up to 16 months, of 2.2 GeV protons on the central nervous system of rabbits following head exposure were studied. The rabbits were exposed to doses of 1650, 5500, and 55,000 rads. Histological studies were performed to determine the extent of damage at the three dose levels. (E.R.B.)

31321 (CERN-71-16(Vol.1 and 2), pp 102-21) PRELIMINARY RESULTS ON THE OPACIFICATION OF THE LENS OF THE EYE IN MICE EXPOSED TO 400-MeV NEUTRONS. Di Paola, M. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari); Bianchi, M.; Baarli, J. (European Organization for Nuclear Research, Geneva (Switzerland)). (In French).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The effects of neutrons on the eyes of mice were determined following whole-body exposure to a 400-MeV neutron beam. The RBE of the neutrons, compared to x rays, was determined for various doses. Lens opacification was the criterion used for determining RBE. (E.R.B.)

31322 (CERN-71-16(Vol.1 and 2), pp 133-50) INVESTIGATION MADE AT CERN INTO THE BIOLOGICAL EFFECTIVENESS OF HIGH-ENERGY RADIATIONS. Baarli, J.; Sullivan, A. H.; Bianchi, M. (European Organization for Nuclear Research, Geneva (Switzerland)); Quintiliani, M. (Istituto Superiore di Sanita, Rome (Italy)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The biological effectiveness of high-energy radiations was investigated at CERN. The following radiations and biological criteria were used: 600-MeV protons for induction of lethal mutations in Drosophila; survival of mice, and weight loss in mouse testes and thymus; 400-MeV neutrons and 80 to 110 MeV pions (positive and negative) for induction of lens opacification, survival of spermatogonia, and weight loss of testes in mice. The RBE values were determined for each combination in comparison with x rays. (E.R.B.)

31323 (CERN-71-16(Vol.1 and 2), pp 174-88) NONUNIFORM DISTRIBUTION OF THE ABSORBED DOSE AND RADIOBIOLOGICAL EFFECT. ASSESSMENT OF RADIATION HAZARD IN SPACE FLIGHTS. Grigor'ev, Yu. G.; Gorlov, V. G.; Budylin, V. N.; Kalandarova, M. P.; Savchenko, H. Ya.; Farber, Yu. V.

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

In order to assess the radiation hazards to astronauts during space flight, animal experiments were conducted to determine the biological consequences of non-uniform irradiation. Dogs and rats were subjected to multi-sided, non-uniform exposures to protons and x rays at a wide range of doses, and the relation between the dose absorbed by the critical organs and the extent of radiation injury and recovery was determined. The following problems were investigated during the course of the study: the dose dependence of animal death; the dependence of hematopoietic system damage on the dose absorbed by bone marrow; and the recovery of skin following non-uniform exposure. It was concluded that in planning permissible radiation doses for astronauts, a distribution coefficient indicating how much less efficient non-uniform irradiation is than uniform irradiation should be employed. (E.R.B.)

31324 (CERN-71-16(Vol.1 and 2), pp 189-202) BIOLOGICAL EFFECTS AND THEIR PREDICTION DURING NONUNIFORM IRRADIATION OF DOGS WITH HIGH-ENERGY PROTONS. Abramova, G. M.; Nevskaya, G. F.; Yurgov, V. V. (Ministerstvo Zdravookhraneniya SSSR, Moscow. Institut Mediko-Biologicheskikh Problem).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The biological effects of non-uniform irradiation of dogs with high energy protons were determined. The dogs were exposed in such a way that the abdomen doses were 3, 5, and 8 times larger than the back doses. Bone marrow damage was the criterion used in determining the biological effect. Three methods for the quantitative evaluation of non-uniform irradiation effects are described. Each method presents certain advantages and the preferential application of one method would depend on the information available to the investigator. Equivalent doses (rads), calculated on the basis of the three methods described, are compared. (E.R.B.)

31325 (COO-1024-44) COMPARISON OF THE CYTOLOGICAL EFFECTS PRODUCED BY IONIZING RADIATIONS OF DIFFERENT LET. Technical Progress Report. (Iowa Univ., Iowa City. Radiation Research Lab.). Mar 1972. Contract AT(11-1)-1024. 13p. Dep. NTIS.

Studies on recovery of x-irradiated intermitotic lens epithelium cells showed that the DNA synthesis was delayed and suppressed in cells that were responding to a wound stimulus. Graphs are presented to show intermitotic cellular recovery. After rat lens epithelial cells were wounded with fission neutrons and pulse labeled with ^{3}H-TdR, microscopic examinations showed abnormal mitotic figures. Experiments were conducted on the length of time that ^{3}H-TdR was available to cells after pulse labeling. Chick embryos were labeled with ^{3}H-TdR and treated with 100 to 800 R doses of x radiation; it was found that the uptake of ^{3}H-TdR decreased with increasing radiation doses. Effects of x-ray dose fractionation on recovery were also investigated. Progress is also reported on visual functions of patients receiving x or gamma-ray therapy in the region of the head and neck. (H.L.W.)

31326 COMPARTMENTS OF LEUKAEMOGENIC RESPONSE TO RADIATION. Ilbery, P. L. T. (Univ. of Sydney). Nippon Igaku Hoshasen Gakkai Zasshi; 31: No. 4, 331-9(Jul 1971).

By cytogenetic methods 88 of 100 radiation induced mouse leukemias were seen to be composed of significant numbers of cells carrying abnormalities of chromosome number and/or form. The incidence of leukemia following the leukemogenic schedule of radiation was lowered by grafting bone marrow or foetal liver. When these grafts, suitably labeled chromosomally, were used post radiation to impede the onset of leukemia, neoplasia supervened only in irradiated cells. The finding is in contrast to the incidence from either irradiated or unirradiated cells in thymic grafts after thymectomy and fractionated radiation. Thymic cells in association with irradiated bone marrow cells colonizing the thymus became neoplastic but non-irradiated bone marrow cells colonizing an irradiated thymus were not rendered neoplastic and indeed had an inhibitory effect in the incidence of leukemia. The findings are discussed in terms of somatic mutation, immunological suppression, clonal explosion, and transformation elimination, and the prevention of radiation-induced leukemia through a bone marrow factor in restoration of thymic competence. (auth)

31327 WAVELENGTH DEPENDENCE OF UV-INDUCED ALTERATIONS OF EPIDERMAL CELLS IN HAIRLESS ALBINO MICE. Jung, E. G.; Bohnert, E.; Erbs, G.; Knobloch, G. v.; Mueller, S. (Univ., Heidelberg). Arch. Dermatol. Forsch.; 241: 284-91(1971).

Ultraviolet radiation is known to produce DNA damage in epidermal cells that can be removed by the mechanism of excision repair, measured by the number of lightly marked cells in autoradiography. Another effect consists in a delay of the mitotic cycle measured by a reduction of heavy labelled S-phases in the basal cell layer. Irradiation was carried out in hairless albino mice by a xenon arc lamp with interference filters and with a prism monochromator. Repairing activity was demonstrated in UV C and B with a high peak from 280 to 290 nm. The relatively low values at 250 and 260 nm are explained by the simultaneously occurring dimer breakage with these wavelengths. This is confirmed by the fact that after 260 nm irradiation we did not find a depression of S-phases in the basal cell layer, while in the range from 270 to 310 nm there is a clear decrease in the number of replicating cells. There is evidence that the spectrum of uv induced repairable DNA alterations in vivo is broader than the absorption of DNA in vitro. (auth)

31328 VISUAL DETECTION OF X RAY BY THE RHESUS MONKEY. Chaddock, Thomas E. (Florida State Univ., Tallahassee). Contracts AT(40-1)-02690; AT(40-1)-2903; F 29600-67-0012. J. Comp. Physiol. Psychol.; 78: No. 2, 190-201 (1972).

Seven experiments were conducted which investigated the immediate detection of x rays with primary emphasis on the visual sensory system and its role in this detection in the rhesus monkey. A conditioned suppression of lever pressing to x-irradiation was used as the dependent variable. An olfactory mediation of x-ray stimulation in light-adapted subjects and a visual mediation in anosmic dark-adapted monkeys were demonstrated. Further investigation of the visual detection demonstrated an exposure-rate threshold of 2–3 mr/sec, a dark-adaptation effect, that detection was related to the intensity of background illumination, that the apparent hue of the x-ray-produced phosphene was blue, and that a blind-anosmic monkey could perform the conditioned suppression response to an auditory stimulus. (auth)

31329 EFFECTS OF ACUTE AND PROTRACTED IONIZING RADIATION ON THE RABBIT LENS. Geeraets, W. J.; Ham, W. T.; Mueller, H. A.; Williams, R. C.; Cleary, S. F. (Virginia Commonwealth Univ., Richmond). Acta Ophthalmol.; 49: 817-55(1971).

The effects of acute x-ray and proton irradiations were investigated on Dutch rabbit lenses. Exposure of rabbit lenses to the higher LET 20 MeV proton beam resulted in more pronounced lens changes than the ones exposed to a lower LET 100 MeV proton irradiation at identical dose levels (25, 50, 100, 250 rad). The effect of proton irradiation for the two energy levels (20 MeV, 100 MeV) in producing lens changes is significantly greater than the effect caused by 1 MeV x-radiation. This is more pronounced for higher dose levels. The biomicroscopic appearance of lens changes produced either by proton irradiation or x-ray is characteristic, but similar for the two modes of exposure. This may indicate that the pathogenesis is the same for the two types of irradiation. The onset of lens changes produced by irradiation to a proton beam was approximately equal to that after x-ray exposure. Progression of lens changes, however, appeared slower for the former. A plateau after which no further lens changes occurred was reached for both types of irradiation about 12 months post exposure. The effects of fractionated x-ray and proton irradiation were also investigated. While in the case of single x-ray exposure to 25 R a final plateau was reached after about 8 months post irradiation, progression of lens changes following fractionated radiation to 25 R over 13 weeks totalling 1000 R extended to about 12 months post-initial radiation. Lens changes after exposure to 30 MeV proton beams, 5 rad per month (total 50 rad), were only slightly lower than for lens changes observed after a single exposure to the same total dose of 50 rad. (auth)

31330 RADIATION STUDIES IN MICE. Puro, Edward Allan. Toronto; Univ. of Toronto (1970). National Library of Canada, Ottawa.

Thesis.

This thesis is a report of studies on the response of mice to x-rays delivered at various dose rates. Female (C57BL/6J x DBA/2J) F_1 mice were exposed to whole-body 250 kVp x-rays delivered at 105, 11.6, 5.37 and 2.86 R/min. Lethality of the mice was observed over a 30-day period post-irradiation. The LD$_{50/30}$ increased with decreasing dose rate throughout the range studied with the greatest change per unit change in dose rate occurring at lower dose rates. Specifically, the LD$_{50/30}$ varied as the inverse of the dose rate raised to the power 0.08. In view of the LD$_{50/30}$ dependence on dose rate, survival times and death distributions of the mice were analyzed for a similar dependence. The results indicated that the time at which the mice died was independent of the dose rate employed. Furthermore, at all dose rates the greatest mortality occurred between 9 to 30 days post exposure. Only 2.6% of the total number of deaths observed at all of the dose rates occurred between day 5 to day 8. No deaths were observed earlier than day 5. From these results, bone marrow injury was interpreted as the primary cause of death of the mice at all dose rates. Since bone marrow injury was implicated as the principal cause of death, the effect of dose rate variation upon hemopoietic stem cell survival as estimated by the ability to form colonies (CFU) was studied. Cells obtained from the femoral marrows of mice were transplanted into irradiated recipient mice. The transplanted cells were subsequently irradiated within the recipients. The survival curves obtained were sigmoidal at all dose rates, although there was a tendency for the curves to become more simply exponential as the dose rate was decreased. Higher dose rates were more efficient in cell killing for dosages above 200 R. Below this dosage there was no apparent effect of dose rate on cell survival. Mice irradiated close to, but below the mid-lethal range are capable of forming colonies on the surface of their spleens without transplantation (endogenous colonies). Endogenous spleen colony assays were performed to test whether the radiosensitivity changes of the transplanted cells were not a result of confounding influences such as trauma during transplantation and differences between the internal milieu of the supralethally irradiated recipient mice and mice irradiated in the mid-lethal range. The radiosensitivity changes of endogenous CFU with dose rate were substantially the same as for those obtained by the transplantation method. The results of the spleen colony experiments suggested a close association of CFU survival and animal lethality in the mid-lethal range. It was proposed that the dose rate effect on animal LD$_{50/30}$ was explainable to a large degree on the stem cell survival at that dose. (Diss. Abstr.)

31331 CHANGES OF ERYTHROCYTE CARBONIC ANHYDRASE ACTIVITY IN GAMMA-IRRADIATED ALBINO RATS. Kiradjiev, G. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 133-7(1967).

The effects of external irradiation on the activity of erythrocytic carbonic anhydrase were studied in rats. The rats were subjected to whole-body ^{60}Co γ irradiation at a dose of either 300, 500, 750, or 2000 R. Carbonic anhydrase activity was determined at 2 hr up to 30 days postirradiation. On the basis of the experimental results, it was concluded that a statistically significant increase in carbonic anhydrase activity per individual erythrocyte occurred starting at day 7 postirradiation. The increases were more pronounced in rats exposed to 500 or 750 R. (E.R.B.)

31332 MECHANISM OF BONE MARROW THERAPEUTIC EFFECT IN INTRAPERITONEAL ADMINISTRATION. Zographov, D. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 127-31(1967).

The therapeutic effectiveness of bone marrow cells following intraperitoneal or intravenous administration was determined. The criterion for effectiveness was the formation of spleen colonies in irradiated hosts by the donor stem cells. Mice were subjected to whole-body γ irradiation at 720 R, and 1 hr later were injected either intraperitoneally or intravenously with equal quantities of bone marrow cells from the same suspension. It was concluded from the data that the intraperitoneal administration of bone marrow suspensions does not lead to spleen colonies originating from donor hematopoietic stem cells. (E.R.B.)

31333 BLOOD CHANGES AND THEIR PROGNOSTIC VALUE AT THE CHRONIC STAGE OF ACUTE RADIATION DISEASE. Zographov, D. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 117-25(1967).

An analysis was performed of blood cell counts in rats surviving supralethal doses of x rays over 30 postirradiation days owing to administration of chemical protectors and bone-marrow grafts. Evaluation is made of the effect of these treatments on recovery of hematopoiesis, the state of which is closely related to the outcome at this stage of the disease. The prognostic usefulness of blood changes is discussed. (auth)

31334 POSTNATAL DEVELOPMENT AND CHROMOSOME ABERRATIONS FOLLOWING PRENATAL GAMMA IRRADIATION IN RATS. Baev, I.; Bairakova, A. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 101-7(1967).

The effects of prenatal irradiation on postnatal development and chromosome aberration frequency were studied in rats. The fetuses were exposed in utero at the 14th day of gestation to ^{60}Co γ rays at doses of 50 or 100 R. Offsprings were examined every 5 days for the first month and every 10 days during the second month after birth. Observations included mortality, delayed growth, nanism, weight of male gonads, toe anomalies, and somatic cell chromosome aberrations. It was concluded that a possible correlation exists between the amount of accumulated persistent chromosome aberrations and the severity of visible radioinduced damage. (E.R.B.)

31335 BEHAVIORAL CHANGES IN RATS X-RAYED DURING THE SECOND HALF OF PRENATAL LIFE. Baev, I.; Paskalev, Z. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 85-93(1967).

The effects of prenatal exposure to ^{60}Co γ radiation on the postnatal behavior of rats were studied. The rats were exposed in utero at day 14 of gestation to doses of 50 or 100 R. The rats were tested for behavioral alterations at 57 to 60 days following birth. Behavioral determinations involved psychosensory performance with or without visual or acoustic stimulation. It was concluded that day 14 of prenatal life is a critical moment in the development of the nervous system as regards radiosensitivity and, specifically, marks the appearance of psychosensory disturbances. (E.R.B.)

31336 RENAL DAMAGE FROM RADIATIONS. EXPERIMENTAL RESEARCH ON THE DOG. Laddaga, M. (Univ., Pisa, Italy). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 89-108(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Kidneys of dogs were partially or totally exposed to 1200 R x radiation. One kidney was removed from some dogs. The functioning and recovery of the exposed kidney was followed for a time following irradiation. It was concluded that the kidney is extremely radiosensitive and that it should be protected as much as possible during radiotherapy. (H.L.W.)

31337 RADIOISOTOPIC EVALUATION OF THE PREMATURE ALTERATIONS OF THE RENAL FUNCTIONALITY INDUCED IN THE RABBIT BY IRRADIATION OF THE KIDNEY. Tarolo, G. L.; Mombelli, L.; Borghi, A.; Roncari, G. (Univ., Milan). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 403-23(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Small fractionated doses of gamma radiation were administered to one kidney each of two groups of rabbits, one group receiving a total dose of 500 R and the other a total dose of 1000 R. Functional changes were studied with the aid of iodine-131-labeled hippuran, radiography, and mercury-197-labeled chlormerodrin scintigraphy. In both groups of rabbits lesions were found in the irradiated kidney 24 hrs after irradiation. After a period of eight days a regression of the changes occurred. Radiographic patterns indicated complete regression while scintigraphic examinations indicated only partial regression. (H.L.W.)

31338 RADIOPROTECTION BY THIOLIC COMPOUNDS IN MICE TREATED WITH LETHAL DOSES OF X RAYS AND SOME RADIOMIMETIC CHEMICALS. Falconi, C.; Porta, E.; Gaetani, B.; Cifaldi, S. (Univ., Naples). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 491-6(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

The survival rate and the hematologic variations were followed in mice exposed to lethal and sub-lethal doses of x radiation followed by administration of dithiothreitol. The preliminary results of studies showed a protective effect of dithiothreitol against the harmful effects of the radiomimetic cyclophosphamide. (auth)

31339 STUDIES ON THE RADIORESTORATIVE EFFECT OF PADUTIN IN WHOLE-BODY IRRADIATED RATS. Gerbaulet, K.; Roumengous, M. (EURATOM, Ispra, Italy). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 503-9(1968).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Repeated intraperitoneal injections of five units of Padutin (callicrein) were administered to male albino rats, starting on the first day after whole-body x-irradiation with sublethal doses of 400 R and lethal doses of 800 R. After lethal doses, such treatment resulted in a reduction of mortality by about 20% and in a prolongation of mean survival time of the same degree. After sublethal doses, a restorative effect on the postirradiation inhibition of growth-rate became evident after two weeks of treatment. A favorable effect on both granulocyte and lymphocyte counts in the peripheral blood, indicating a therapeutic effect on bone-marrow regeneration, could not be ascertained within the 30-day period of observation. (auth)

31340 LEVULOSE IN EXPERIMENTAL ACUTE PAN-IRRADIATION STRESS. CHANGES IN ADRENOCORTICAL ASCORBIC ACID AND CHOLESTEROL. Loscalzo, B.; Porta, E.; Nistico, G.; Jula, G. (Univ., Naples). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 518-22(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

In white rats which had been treated with 20% levulose (2.5 cm/100 g weight) intraperitoneally, the depletion of adrenocortical ascorbic acid and cholesterol, caused by single whole-body x-irradiation with 800 R or 1500 R was determined at different time intervals. Levulose did not have any protecting effect on the adrenocortical biochemical changes investigated. (auth)

31341 LEVULOSE IN EXPERIMENTAL ACUTE PAN-IRRADATION STRESS. CHANGES IN BLOOD CORTICOSTERONE. Loscalzo, B.; Porta, E.; Nistico, G.; Jula, G. (Univ., Naples). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 523-5(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Plasma corticosterone was determined at different times in white rats, treated (25 cm^3/10 g weight) with 20% levulose intraperitoneally and subjected or not to a single whole-body dose of x irradiation with 800 R or 1500 R. After radiation stress, blood steroid increased significantly; levulose did not show a protective action on the adrenocortical reaction following the acute pan-irradiation. (auth)

31342 EFFECTS OF LYSOZYME ON THE FORMATION OF ENDOGENEOUS SPLENIC COLONIES IN THE RAT AFTER PAN-IRRADIATION. Oliva, L.; Cittadini, G.; Marchi, B. (Univ., Siena, Italy). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 530-42 (1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

The effects of single or repeated administration of lysozyme chloride (20 mg/g e.p.) upon endogeneous splenic CFU's in Swiss rats were studied before and after irradiation (x-rays; 750 rad). The administration of lysozyme after irradiation (30 min.; 24 hrs; 24 + 48 + 72 hrs) did not cause a variation in the number of splenic colonies or in the weight of the spleen. On the contrary, administration of lysozyme before irradiation (72 + 48 + 24 hrs; 24 hrs; 30 min.) caused a significant decrease in the number of splenic colonies but no decrease in the weight of the spleen. It was shown that, in the animals treated with lysozyme 72 + 48 + 24 hours before irradiation, there was significant increase in LD 50/30 (gamma radiation from ^{60}Co), representing a protective action against the marrow type mortality. Therefore there is a dissociation between the behavior of the splenic CFU's and the marrow type mortality. The decrease in the number of the splenic colonies, representing a depression in the total blastic capability at the splenic level, seems to be due more to an induction of the evolution of the blastic splenic cells toward the differentiative compartment, rather than to their sensitization to irradiation by lysozyme. (auth)

31343 MANGANESE TURNOVER STUDY IN NORMAL AND PAN-IRRADIATED RATS. Ott, H.; Pirrwitz, D. (CCR-EURATOM, Ispra, Italy). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 638-47(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Since radioactive isotopes of manganese are considered to be potential contaminants in nuclear reactor technology, the effect of external x irradiation on the turnover and hepatic uptake of manganese was studied in rats using ^{54}Mn as a tracer. The excretion of manganese is almost exclusively fecal. External irradiation (450 R) resulted in a lower excretion during the first day, followed by an increased excretion during the following days. Decontamination by means of EDTA was ineffective unless the chelating agent was applied immediately after injection of ^{54}Mn. Excretion of ^{54}Mn was accelerated by increasing the dietary intake of stable manganese. (auth)

31344 POSTIRRADIATIONAL TISSUE ALTERATIONS IN ANIMALS PRE-TREATED WITH CYCLOPHOSPHAMIDE. Romanini, A.; La Porta, S.; Caruso, G. (Univ., Rome). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 648-70(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Differences in reactions in irradiated tissues in animals previously treated with antimitotics, particularly cyclophosphamide, were examined. Alterations not evident at first were detected by histometric methods. Morphological examinations showed that tissues pretreated with antimitotics were less radiosensitive than controls. (H.L.W.)

31345 GLUCURONIDE METABOLISM IN THE RAT AFTER A SUBLETHAL DOSE OF IONIZING RADIATION. Scoppa, P. (CCR-EURATOM, Ispra, Italy). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 681-95(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

Urinary excretion of glucuronides in rats was markedly altered following whole-body x irradiation with sublethal doses (400 R). Experiments performed using pair fasted rats as controls demonstrate the influence of the acute gastrointestinal syndrome on the decrease of glucuronides in the urine of the irradiated animals. The synthesis of conjugation products of glucuronic acid was strongly dependent on the quantity of food consumed. The determination of the activities of some enzymes involved in the liver metabolism of glucuronic acid revealed that exposure to ionizing radiation does not cause effects different from those obtained in pair fasted controls. (auth)

31346 INFLUENCE OF DRUGS ON THE POST IRRADIATION DISORDERS OF BLOOD COAGULATION. Klír, P.; Pospísil, J.; Skala, E.; Dienstbier, Z. Vnitr. Lek.; 17: No. 10, 937-42 (Oct 1971). (In Czech).

Ellagic acid decreases significantly the blood loss in rats after whole body irradiation if administered in doses of 10 ml/kg of 2.10^{-4}M solution. Under the same conditions haemarctin, reptilase and dicynone were without effect. Ellagic acid in experiments in vitro normalized a pathological TEG record of a hemophilic blood, the effect of heparin was blocked and it prolonged the coagulation time of prothrombin consumption test of blood of healthy subjects. (auth)

31347 LOCALIZATION AND TRANSMISSION OF A VIABLE CHROMOSOMAL MUTATION IN PLEURODELES WALTLII MICHAH. **Labrousse, M. (Faculte des Sciences, Paris). Chromosoma; 33: 409-20(1971). (In French).**

A heterozygous reciprocal translocation between chromosomes 5 and 9 has been induced by γ rays in a fertilized egg of Pleurodeles waltlii. The resulting mutant female gave rise to offspring which, karyotypically, illustrated the six categories of gametes to be expected in the translocation heterozygote. Correspondence was established between these different chromosomal combinations and normal or abnormal first generation phenotypes. Mutation "T" was linked to a partial monosomy (5)-trisomy (9). The structural analysis of the chromosomes at the somatic level led to the interpretation of the segments involved in the initial arrangement. It consists of a reciprocal translocation probably accompanied by a pericentric inversion, without evident loss of genetic material. (auth)

31348 MODIFICATION OF RADIATION RESPONSE AND TERATOGENIC ACTION BY DIMETHYL SULPHOXIDE IN CHICK EMBRYOS. Mawhinney, B. S.; Schenken, L. L. (Univ. of Iowa, Iowa City). Nature (London) New Biol.; 236: No. 66, 155-6 (5 Apr 1972).

The following .9% solutions of dimethyl sulphoxide (DMSO) were applied to the inner shell membrane of fertile hens' eggs; 5 mg/ml, 10 mg/ml, 20 mg/ml, 50 mg/ml, 100 mg/ml, and 200 mg/ml. Embryos of 72 h and 240 h were used as the most radiosensitive ages. Immediately after the addition of the test solutions, the embryos were x-irradiated or sham irradiated. Exposure for 72 h embryos was 600 R and for 240 h embryos was 450 R (70% of the $LD_{50/17\,day}$). The embryos were examined on the 17th day of incubation. The results indicated that LD_{50} drug dose at 72 h was 18 mg and at 240 h, 58 mg. The results were not significantly altered by radiation. There was also a highly specific teratogenic response (anophthalmia and modified beak development) that appeared to be drug dose dependent, but independent of radiation. Parallel and synergistic responses between x irradiation and the activity of DMSO were seen in the embryo weight data and decrease in tibia length. (UK)

31349 INEFFECTIVENESS OF THE TETANAL ANATOXIN ADMINISTERED TO IRRADIATED ORGANISMS. **Strati, I.; Popescu, Al. Rev. Sanit. Mil.; 74: No. 5, 545-8(Sep-Oct 1971). (In Rumanian).**

Mice and rats exposed to x-ray doses of 300 to 700 R were inoculated intraperitoneally or subcutaneously with 1 to 2 mg of tetanus toxoid. Study showed the survival rate was not higher than in animals that were not inoculated after irradiation. The toxoid did not protect rats that at the end of the period were administered 2 LD_{50} doses of tetanus toxoid, regardless of whether they were or were not previously exposed to radiation. The toxoid strength on the tenth day after two inoculations of 2 mg of tetanus toxoid each during the 30-day period was found to be lower in rats irradiated two hrs before the first inoculation than in the unirradiated animals. (JPRS)

31350 EFFECT OF ATP RADIATION-CONDITIONED CHROMOSOMAL ANOMALIES IN RATS WHEN USED AS A RADIOPROTECTIVE AND THERAPEUTIC AGENT. **Baev, I.; Bairakova, A.; Benova, D.; Nikolov, I. Rentgenol. Radiol.; 10: No. 2, 69-73(1971). (In Bulgarian).**

Chromosomal analysis was carried out on bone marrow cells of rats exposed to a single x-ray dose of 800 R with pre- and post-irradiation administration of ATP. Readings were performed on the 18th hr and on the 9th and 30th day after irradiation. Administration of the compound as a protector was shown to reduce essentially the incidence of radiation-induced chromosomal anomalies on the 18th hr after exposure. The effect of its post-irradiation administration and the effect in the late post-irradiation periods (9 and 30 days) were mild. The radioprotective dose of 350 mg/kg of ATP applied without irradiation failed to affect the incidence of chromosomal anomalies. (auth) (Abstr. Bulg. Sci. Med. Lit.)

31351 AET FOR IONIZING RADIATION PROTECTION OF ANIMALS. **Kartashov, P. A. (All-Union Inst. of Experimental Veterinary, Moscow). Veterinariya; 11: 81-3(Nov 1970). (In Russian).**

Amituron [AET], (s-(2-aminoethyl)isothiuronium bromide hydrobromide) is a known effective prophylactic against radiation injury. Experiments were conducted with five irradiated sheep (300 to 450 R of γ radiation) with AET administered at various periods of time. The results support the findings of previous workers concerning the effectiveness of AET against external irradiation by x or gamma rays. (K.S.W.)

31352 INFLUENCE OF IRRADIATION ON THE DISTRIBUTION OF ACID PHOSPHATASE IN THE CERVICAL LYMPH NODES OF MICE. **Gibertini, Giancarlo; Filoni, Sergio; Catalini, Nicola (Univ., Rome). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 50: No. 2, 255-8(Feb 1971). (In Italian).**

The effect of x rays (450 R) on the distribution of acid phosphatase in the cervical lymph nodes of whole-body irradiated young mice was studied. Immediately after irradiation, the cortex of lymph nodes displayed a higher enzymatic activity than the medulla. The intense enzymatic activity was localized in the lymphatic nodules of lymph nodes, and it was particularly evident in their central germinal. The higher acid phosphatase content observed following x irradiation suggested two populations of lymphocytes characterized by a different radiosensitivity, as was detected in the thymus. (auth)

31353 EFFECT OF A SINGLE X-RAY DOSE ON THE LEUKEMOGENIC ACTIVITY OF ACELLULAR EXTRACTS FROM AN EXPERIMENTAL CHLOROMA IN MICE. Chamorro, A. (Institut du Radium, Paris). Compt. Rend. Soc. Biol.; 165: No. 5, 994-7(1971). (In French).

Acellular extracts of an experimental chloroma induced 68% Friend type leukoses and 32% myeloid leukoses in Swiss mice. A single 400 R x-ray dose given in toto 48 hours before the administering of the extract caused the partial inhibition (35%) of the Friend leukoses and an increase in the number (65%) of myeloid leukoses, the preferred appearance of pathological transformations occurring with the most radiosensitive cells. (France)

31354 RESPONSE OF THE BURRO TO LOW DOSE RATE ^{60}Co GAMMA RADIATION. Wykoff, M. H. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Health Phys.; 22: No. 5, 483-5(May 1972).

Four burros were exposed to 360 rads ^{60}Co gamma radiation at the rate of 0.21 rads/min. Only one of these burros displayed the central nervous system syndrome. This burro died on the 6th day after irradiation. The other 3 burros survived 18 to 21 days. Hypoxia and hyperglycemia was found in venous blood samples from all burros. (UK)

31355 PROBLEM OF THE RADIOSENSITIVITY OF THE EPITHELIUM OF TUBA FALLIOPII. **Tileva, M. D. Folia Med. (Sofia); 13: No. 2, 75-85(1971). (In German).**

Albino rats were tested for radiosensitivity of the epithelium of the fallopian tubes. Fallopian tube cells, originating from rats subjected to preliminary x irradiation with 2000 R, were implanted in the animals. Cells taken from unirradiated rats were implanted in a control group of animals. Microscopic examinations of the implanted tissues were made on the 1st, 3rd, 5th, 7th, and 10th day after the operation. The following criteria for sensitivity were used: growth and differentiation of the cells, activity of their division, DNA-synthesis, parameters of S-phase, and regeneration time. It was found that the growth of the irradiated and unirradiated cells was the same, all their basic properties being preserved; damage to the irradiated cells was manifested by retarded division; regeneration time is prolonged threefold; and the S-phase duration does not change and is comparatively short (2.9 hrs). Bearing in mind these results and proceeding from the generally accepted rule that radiosensitive tissues are those whose cells display severe radiation damage at a total dose of less than 2500 R, a conclusion is drawn that the cells of the fallopian tubes are relatively radioresistant. (Abstr. Bulg. Sci. Med. Lit.)

31356 HISTOPATHOLOGICAL STUDY OF SPLEEN AFTER 600 R ^{60}Co EXTERNAL IRRADIATION IN INDIAN DESERT GERBIL (MERIONES HURRIANAE JERDON). Kumar, Ashok; Srivastava, P. N. (Univ. of Rajasthan, Jaipur, India). Strahlentherapie; 142: No. 6, 721-5(Dec 1971).

Adult Indian desert gerbils (Meriones hurrianae Jerdon) were collected from the vicinity of Jaipur. The animals were exposed to the dose level of 600 R by a cobalt source and were autopsied 1, 2, 3 days and 1, 2, 4 weeks after irradiation. The spleen shows reduction in the size as well as in the number and size of the lymphatic nodules, due to loss of lymphocytes. The maximum reduction is observed at 1 week. Reparation starts after 2 weeks of irradiation, and a more or less normal picture of spleen is observed at 4 weeks. (auth)

31357 BIOLOGICAL EFFECTS OF FAST NEUTRONS. **Porschen, W. (Institut fuer Medizin, Juelich, Ger.). Kerntechnik; 14: No. 1, 29-34(Jan 1972). (In German and English).**

Fast neutrons have a lower oxygen enhancement ratio than either γ rays or x rays, and are therefore of interest for radiation biology and radiation therapy. The effect of fast neutrons on the growth of experimental tumors was studied on sarcoma 180. For determining the relative biological effectiveness of fast neutrons, we also measured with a whole-body counter for laboratory animals the irradiation-induced depression of the incorporation of a radioactively labeled precursor into the DNA of proliferation cells of the mouse. (auth)

31358 ELECTRON MICROSCOPIC STUDIES ON POLYSOME ENRICHMENT IN THE LIVER CELLS OF X-IRRADIATED GUINEA-PIGS. Unger, Emil; Hidvegi, Egon (National Research Inst. for Radiobiology and Radiohygiene, Budapest). Strahlentherapie; 142: No. 6, 726-33(Dec 1971).

The distribution of ribosomes in the liver of guinea-pigs in ultrathin sections under the electron microscope by parallel electron microscopic visualization of isolated ribosomal preparation and by sucrose density gradient centrifugation was studied. As established, 5 to 24 hours following whole-body x-irradiation with 1000 to 4000 R, polysomes enriched in the liver cells, reaching the maximum after 9 to 15 hours. On the basis of the results and of earlier biochemical investigations the conclusion was drawn that supralethal wholebody irradiation accelerates RNA synthesis in the liver. This results in polysome enrichment, with the incidental enhancement of protein synthesis. (auth)

31359 DOSE-RATE EFFECT ON TRANSLOCATION INDUCTION BY X-IRRADIATION OF MOUSE SPERMATOGONIA. Searle, A. G.; Beechey, C. V.; Corp, M. J.; Papworth, D. G. (Medical Research Council, Harwell, Eng.). Mutat. Res.; 15: No. 1, 89-91(May 1972).

The effects of low dose rates on the frequency of reciprocal translocations in mouse spermatocytes following x irradiation of the spermatogonia from which they arise were studied. Male mice were given continuous whole-body irradiation at dose rates of 93, 0.87, and 0.09 rad/min. The total dose was 300 rad. The translocation frequencies at 0.87 and 0.09 rad/min were less than half those at 93 rad/min. The difference was highly significant. (E.R.B.)

Invertebrates

Refer also to abstract 31273.

31360 STUDY ON THE EFFECTIVENESS OF ^{60}Co IRRADIATION AGAINST S. GRANARIUS AND T. CONFUSUM DUV. Esin, Tarik; Alganatay, Meral. Bitki Koruma Bul.; 8: No. 1, 39-60(Mar 1968). (In Turkish).

Adult and larvae of Sitophilus granarius L. and Tribolium confusum were exposed to ^{60}Co γ radiation at doses of 16000 and 10.000 to 30.000 rads respectively. Morbidity of 100% was observed in adults of Sitophilus granaris L. after 20 days exposure to 16.000 rad dose which was also found effective for the larvae. A morbidity rate of 100% was attained by exposure to 10.000 to 30.000 rads for 40 to 45 days in the adults of Tribolium confusum, while 25 days exposure at the same dose sufficed to kill the larvae. (auth)

31361 LOCUS SPECIFICITY OF MUTAGENS IN DROSOPHILA. Jain, H. K.; Shukla, P. T. (Indian Agricultural Research Inst., New Delhi). Mutat. Res.; 14: No. 4, 440-2(Apr 1972).

Larvae of Drosophila melanogaster were treated with EMS, hydroxylamine, hydrazine, and x radiation and the adult males developing from these larvae were mated with females with attached X chromosomes. The F$_1$ males were then examined for visible mutations and the results are tabulated. Results showed that variance within mutagens was vastly inferior to that between mutagens, and the existence of locus specificity of the mutagens was confirmed. (H.L.W.)

31362 EFFECT OF DIMETHYL SULPHOXIDE ON THE RADIOSENSITIVITY OF THE SPERM OF DROSOPHILA MELANOGASTER AT TWO STAGES OF ITS MATURATION. Mazar Barnett, Beatriz (Comision Nacional de Energia Atomica, Buenos Aires). pp 501-4 of Induced Mutations and Plant Improvement. Vienna; International Atomic Energy Agency (1972). (In Spanish).

From Meeting on induced mutations and plant improvement; Buenos Aires, Argentina (16 Nov 1970). See STI/PUB-297; CONF-701125.

Data are presented on differences in the action of ionizing radiations observed at two very slightly separated stages in the gametogenesis of Drosophila melanogaster, when a radioprotective compound is present and absent. The last two stages of spermiogenesis were studied (immobile sperm and mature, mobile sperm). The genetic effect of the treatments was investigated at the level of chromosome breakage and recombination in II–III translocation experiments. X-radiation was employed, the dose being 1000 rad in all cases. The radioprotective agent, 10% dimethyl sulphoxide, was administered by intra-abdominal injection before irradiation. Pre-treatments were carried out at various times. The experimental procedure followed for crossings-over permits adequate sampling of the germinal cells at the stages mentioned. The results obtained in the translocation tests do not indicate differences in radiosensitivity between the two stages of sperm maturation. On the other hand, these cells exhibit a distinct response to dimethyl sulphoxide, which has a radioprotective effect on immobile sperm without modifying the frequency of translocations induced in mobile sperm. In the case of males treated 30 min before irradiation, the differences are very significant, indicating that this fact must be taken into account. (auth)

31363 SEX-INFLUENCED REVERSION OF THE MUTATIONALLY UNSTABLE MUTANT FORKED-3n OF DROSOPHILA MELANOGASTER. Woodruff, R. C.; Bowman, J. T.; Simmons, J. R. (Utah State Univ., Logan). Mutat. Res.; 15: No. 1, 86-9 (May 1972).

The spontaneous and x-radioinduced reversion frequencies of the unstable forked-3n mutant of Drosophila melanogaster were studied. Spontaneous reversions occurred at a significantly lower frequency in males than in females. Exposure of females to x rays significantly increased the reversion frequency. Previous experiments confirmed a significantly increased reversion frequency in x-irradiated males also. The preliminary data indicate that a sex-linked gene may be responsible for the sex-based dichotomy observed in the reversion frequencies. (E.R.B.)

31364 DOSE-RESPONSE OF CHIASMA FREQUENCY TO X-RADIATION IN CHORTHIPPUS BRUNNEUS. Westerman, M. (La Trobe Univ., Bundoora, Australia). Mutat. Res.; 15: No. 1, 55-65(May 1972).

The number of chiasmata formed in the common British grasshopper Chorthippus brunneus can be altered by low doses of x rays if these are given at any one of four discrete periods in meiosis. During the first of these periods, which corresponds with the time of premeiotic DNA-synthesis, x irradiation significantly depressed mean cell chiasma frequency when compared with the controls. In contrast, the same dose given at leptotene or at late zygotene-early pachytene significantly increased this metric. In all cases, it was found that maximum response was obtained with the lowest dose used (75 rad given at 100 rad/min), higher doses producing no further increase. The pattern of response of the remaining sensitive period, corresponding with late leptotene-early zygotene, was different. Here the reduction in chiasma frequency appeared to be greater with the higher doses. Indeed at this time the only significant reduction in mean cell chiasma frequency was obtained with the highest dose used (225 rad). An attempt was made to interpret the effects of x rays in terms of an interference of repair processes with the normal meiotic sequence. (auth)

31365 GENETIC CONTROL OF MUTATION INDUCTION IN DROSOPHILA MELANOGASTER. I. SEX-CHROMOSOME LOSS IN X-RAYED MATURE SPERM. Wuergler, F. E.; Maier, P. (Swiss Federal Inst. of Tech., Zurich). Mutat. Res.; 15: No. 1, 41-53(May 1972).

After x irradiation of mature sperm of Drosophila melanogaster males carrying a genetically marked ring-X- and a genetically marked Y-chromosome, a high rate of sex-chromosome loss was observed. It is estimated that about three quarters of the losses resulted from damage induced in ring-X-chromosomes. The processes leading to chromosome loss were modified by maternal influences. This is indicated by the observation that with groups of identically treated males the rate of recoverable sex-chromosome loss depended on the type of female used. Owing to uncertainties with respect to the mechanism of radiation-induced chromosome loss, the mode of action of the maternal factors could not yet be determined. (auth)

31366 X-RAY-INDUCED LOSS OF THE MATERNAL SECOND CHROMOSOME IN INSEMINATED EGGS OF DROSOPHILA MELANOGASTER. Wuergler, F. E.; Ruch, P.; Graf, U. (Swiss Federal Inst. of Tech., Zurich). Mutat. Res.; 15: No. 1, 31-40 (May 1972).

Loss of the maternal chromosome II was determined after x-ray treatment of freshly laid eggs. The eggs were obtained from a cross of wild-type females to compound-II males. Losses were recovered only if the maternal chromosomes were irradiated during anaphase of meiosis I (i.e. up to 6 min after egg deposition). After treatment of later stages no losses were recovered. It is calculated that in 0.57% of the eggs, treated immediately after deposition, maternal chromosome-II losses were induced by 500 R. The data indicate that only about 10% of the radiation-induced postblastoderm lethality resulted from complete loss of individual chromosomes. (auth)

31367 EFFECTS OF X RAYS ON MORPHOGENESIS IN THE HOUSEFLY. **Sivasubramanian, P.; Bhaskaran, G.; Nair, K. K.** (BARC, Bombay). **J. Insect Physiol.; 16: No. 1, 89-97(1970).**

Studies on the radiosensitivity of the imaginal disks in developing housefly pupae show that morphogenetic movements associated with the eversion of the head and appendages are not affected by doses of x rays up to 10,000 R, whereas differentiation is drastically affected. With increase in the age of the pupa at the time of irradiation, there is a progressive reduction in the incidence of morphological abnormalities. It is also evident that there is an anteroposterior gradient with respect to radiosensitivity and that it corresponds to the temporal pattern of differentiation. The head is the most resistant to radiation, the thorax less so, and the abdomen is the most sensitive. The epidermal cells of the head and thorax are less sensitive than those of the abdomen. The various imaginal disks show differential sensitivity to x irradiation. Moreover, the different fields in a single disk are also differentially sensitive to x radiation. The prothoracic leg disks are the most resistant followed by the meso- and metathoracic leg disks. In addition, the distal regions of the appendages are more resistant than the proximal ones. In irradiated groups, the appendages of the head are reduced in size but are well differentiated, whereas the thoracic appendages, though of normal length, are poorly differentiated. The critical phase of radiosensitivity of the developing imaginal disks ends after the evagination of the head, and probably reflects the completion of the gene activation process in the cells. (Ind. Sci. Abstr.)

Radionuclide Effects (Internal Source)

Man

31368 (ANL-7860(Pt.2)) RADIOLOGICAL PHYSICS DIVISION ANNUAL REPORT, JULY 1970-JUNE 1971. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 325p. Dep. NTIS.

AIR—radon-222 monitoring in uranium mine, methods for
ALKALINE EARTH METALS—metabolism in man, development of biological model for
ALPHA PARTICLES—dose to human fetuses from radium-226 or radium-228 deposited in maternal skeleton
—effects on chromosomes in circulating lymphocytes following injection in man of radium-226 or radium-228, effects of dose on aberrant
—dose to human skeleton as a function of time following uptake of radium-226 or radium-228, formula for calculation
—effects on human skeleton following uptake of radium-226 or radium-228, pathological
BIOLOGICAL MODELS—development of human, for metabolism of barium, calcium, radium, and strontium
—development for calcium metabolism in mammalian bones
BONES—hypermineralization of hyversian canals in human, following uptake of radium-226 or radium-228, radiographic demonstration of
—calcium-45 distribution and retention in, of dogs and rabbits following intravenous injection, autoradiographic study of
—biological model for calcium metabolism in mammalian
BREATH—radon-222 content of human, as a function of time following uptake of radium-226
CALCIUM-45—distribution and retention in bones of dogs and rabbits following intravenous injection of, autoradiographic study of
CANADA—radioisotope content of man residing in Northern, relation of diet to cesium-137, lead-210, and polonium-210
CESIUM-137—content of man residing in Northern Canada, relation of diet to
CHROMOSOMES—radioinduced aberrations of, in human peripheral blood lymphocytes following injection of radium-226 or radium-228, effects of dose on α
DOGS—calcium-45 distribution and retention in bones of, following intravenous injection, autoradiographic study of
FETUSES—radiation dose to human, from radium-226 or radium-228 deposited in maternal skeleton, α
GAMMA RADIATION—dose to man following injection of radiation-226 or radium-228, methods for estimation of
LEAD-210—distribution in human tissues following ingestion of radium-226, time dependence of
—content of man residing in Northern Canada, relation of diet to
LEAD-214—determination of, response of semiconductor and solid scintillation detectors for in vivo
LYMPHOCYTES—radioinduced aberration of chromosomes in human peripheral blood, effects of dose on α
MAMMALIA—plutonium-239 distribution and retention in tissues of, following ingestion
MAN—radiation dose distribution in, following injection of radium-226 or radium-228, relation to incidence of neoplasms
—radiation dose distribution in, following injection of radium-226 or radium-228, methods for estimation of γ
—radiation dose to bone marrow of, during diagnostic radiography, x
—sarcoma distribution in skeleton of, following injection of radium-226 or radium-228
—radiation effects on reproductive capacity of, following injection of radium-226 or radium-228
—radiation dose to fetuses of, from radium-226 or radium-228 deposited in maternal skeleton, α
—radioinduced aberrations of chromosomes in peripheral blood lymphocytes of, following injection of radium-226 or radium-228, effects of dose on α
—hypermineralization of hyversian canals in bones of, following uptake of radium-226 or radium-228, radiographic demonstration of
—radium-226 distribution in tissues of, following ingestion during use of luminous paint incorporated
—radioisotope distribution in tissues of, following ingestion of radium-226, time dependence of lead-210 and polonium-210
—radiation dose to skeleton of, as a function of time following uptake of radium-226 or radium-228, formula for calculation of α
—radiation effects on skeleton of, following uptake of radium-226 or radium-228, pathological
—radium-226 content of, relation to content of radon-22 in breath
—biological model of, development for metabolism of barium, calcium, radium, and strontium
—radium-226 distribution and retention in tissues of, following injection
—radioinduced neoplasms in, following injection of thorium-232 as Thorotrast
—plutonium-239 distribution and retention in tissues of, following ingestion
—radioinduced neoplasms in bones of, following injection of radium-226 or strontium-90, electron microscopic study of
—radioisotope content of, residing in Northern Canada, use of renal excretion rates to measure cesium-137, lead-210, and polonium-210
—radioisotope content of, residing in Northern Canada, relation of diet to cesium-137, lead-210, and polonium-210
MICE—radioinduced neoplasms in bones of, following injection of radium-226 or strontium-90, electron microscopic study of
MINES—radon-222 monitoring in uranium, methods for
NEOPLASMS—sarcomas, radioinduced in human bones following injection of radium-226 or radium-228
—sarcomas, distribution in human skeleton following injection of radium-226 or radium-228
—leukemia, incidence in man following injection of thorium-232 as Thorotrast
—sarcomas, incidence in man following injection of thorium-232 as Thorotrast
—radioinduced, in bones of man and mice following injection of radium-226, electron microscopic study of
—radioinduced, in bones of man and mice following injection of strontium-90, electron microscopic study of
PLUTONIUM-239—distribution and retention in tissues of man following ingestion, comparison with animal data on
POLONIUM-210—distribution in human tissues following ingestion of radium-226, time dependence of
—content of man residing in Northern Canada, relation of diet to
RABBITS—calcium-45 distribution and retention in bones of, following intravenous injection, autoradiographic study of
RADIATION DETECTORS, SCINTILLATION (SOLID)—response of CsI(Tl) and NaI(Tl), for in vivo measurement of lead-210
RADIATION DETECTORS, SEMICONDUCTOR (GERMANIUM)—response of Ge(Li), for in vivo measurement of lead-210
RADIATION DETECTORS, SEMICONDUCTOR (SILICON)—response of Si(Li), for in vivo measurement of lead-210
RADIATION DOSIMETERS, BIOLOGICAL—efficiency of chromosome aberrations in human peripheral blood lymphocytes as, α
RADIOGRAPHY, BIOMEDICAL—radiation dose to human bone marrow during diagnostic, x
RADIUM-226—radiation dose to man following injection of, relation to incidence of neoplasms
—radiation dose to man following injection of, methods for estimation of γ

—effects on man following injection of, carcinogenic
—effects on reproductive capacity of man following injection
—radiation dose to human fetuses from, deposited in maternal skeleton, α
—radiation dose to human skeleton following uptake of, formula for calculation of α
—content of man, relation to content of radon-222 in breath
—distribution and retention in human tissues following injection
—effects on bones of man and mice following injection of, neoplastic
RADIUM-228—radiation dose to man following injection of, relation to incidence of neoplasms
—radiation dose to man following injection of, methods for estimation of γ
—effects on man following injection of, carcinogenic
—effects on reproductive capacity of man following injection
—radiation dose to human fetuses from, deposited in maternal skeleton, α
RADIUM-226—distribution in human tissues following ingestion during use of luminous paint incorporating
RADIUM-228—radiation dose to human skeleton following uptake of, formula for calculation of α
RADON-222—content of blood of pregnant man with radium-226 deposited in skeleton, relation to radiation dose to fetus
—content of human breath as a function of time following uptake of radium-226
—monitoring in uranium mine air, methods for
SKELETON—sarcoma distribution in human, following injection of radium-226 or radium-228
—radiation dose to human, as a function of time following uptake of radium-226 or radium-228, formula for calculation of α
STRONTIUM-90—effects on bones of man and mice following injection of, neoplastic
THORIUM-232—effects on man following administration as Thorotrast, relation of time to carcinogenic
THORIUM OXIDES ThO_2—distribution and retention in human tissues following administration of thorium-232 incorporated, as Thorotrast
URANIUM ORES—radon-222 monitoring in mines for, methods for
X RADIATION—dose to human bone marrow from, during use for diagnostic radiography, (W.H.K.)

31369 INTERNAL DOSE TO LUNGS IN OCCUPATIONAL EXPOSURE TO RADON AND RADON DAUGHTER PRODUCTS, AND ON THE APPROACH TO ITS DETERMINATION AND SETTING OF NORMS. Ivanov, Z. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 77-83(1967).

Studies on the deleterious effects of radiations on personnel who are occupationally exposed to radon and radon daughter products are dependent upon the accurate assessment of the radiation dose to the lungs. This can be derived from the degree of radon daughter retention in the respiratory pathways and the lung alveoli. Retention, however, is dependent on a complex set of interacting factors that are specific for a given environment. A method is described for measuring the end-effect of these interacting factors. The method is based on the difference between inhaled and exhaled aerosols, using total alpha activity of aerosol particles as the end point. The operation of the filter systems is described and some experimental results are discussed in relation to establishment of MPC norms for radon (in steady state with its daughter products). (E.R.B.)

31370 BIOLOGICAL PROBLEMS CONNECTED WITH THE PRESCRIPTIONS OF PROTECTION FOR INTERNAL IRRADIATION. Breuer, F. (CNEN, Rome). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 440-54(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

The importance of a knowledge of metabolic mechanisms is emphasized in relation to determination of radiation dose distribution and relative retention in various organs and tissues following the uptake of radioisotopes. It is pointed out that inaccuracies in dose calculations are due to lack of knowledge of radionuclide metabolism and normal individual variations in single individuals of a population. The effects of variability on the biological half-life of inhaled ^{137}Cs are examined with reference to the whole-body radiation dose. The effects of variability on iodine uptake by the thyroid with reference to the radiation dose following the uptake of ^{131}I are also examined. The difficulties in dosimetry of bone-seeking isotopes are discussed. A review is also presented of biological factors involved in dosimetry involving the lungs, gastrointestinal tract, and skin. (H.L.W.)

31371 PHYSICAL AND PHYSIOLOGICAL FACTORS IN THE VARIABILITY OF THE HYPERTHYROIDISM RADIOTHERAPY RESULTS. Cirla, A.; Tarolo, G. L.; Colombo, L.; Mombelli, L. (Univ., Milan). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 550-61(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

A group of patients with hyperthyroidism (47 with Basedow disease, 15 with Plummer disease) was examined to identify the causes of variations in the results of ^{131}I treatment. The most significant factor was the broad dispersion of the absorbed β doses in the gland for the same activity of radioiodine, so that in many patients following the usual schemes of treatment the therapeutic dose was not reached. Other causes which can explain the variability of the results obtained were the non-uniform distribution of the doses at a microscopic level and radioresistance, which depends on biological factors that cannot be exactly determined. (auth)

Animals

31372 (BNWL-SA-4124) PATHOLOGIC EFFECTS OF CHRONIC ^{90}Sr INGESTION IN MINIATURE SWINE. Ragan, H. A.; Hackett, P. L.; McClanahan, B. J.; Clarke, W. J. (Battelle Pacific Northwest Labs., Richland, Wash.). [1972]. Contract AT-(45-1)-1830. 31p. (CONF-720108-3). Dep. NTIS.

From Conference on research animals in medicine; Washington, D. C. (28 Jan 1972).

Over 700 female miniature swine, extending through three generations, were exposed to daily feedings of from 1 to 3100 μCi ^{90}Sr. In addition, there were 200 untreated, female, littermate controls. Body burdens of ^{90}Sr reached approximately 7.5 and 10 times the daily intake in the original and F_1 and F_2 generations, respectively, with the soft tissue radiation doses ~1/1000 that for bone. Although radiation osteitis was a common finding, only 7 pigs had evidence of 11 individual bone tumors, with >80% occurring in the skull. These tumors were classified morphologically as osteosarcomas (73%) or giant cell tumors (27%). The most consistent disorders associated with chronic ^{90}Sr feeding were effects on the hematopoietic system. At levels >25 μCi/day (5000-20,000 rads accumulated skeletal doses), there occurred a progressive decrease in circulating leukocytes and platelets, and a precipitous, terminal fall in erythrocytes, with many of these animals dying of hemorrhagic diatheses. A second syndrome, observed particularly in animals at the 125 and 625 μCi/day levels, was a broad spectrum of myeloproliferation ranging from myeloid metaplasia to blast cell leukemia. (auth)

31373 (UR-3490-89) RADIATION EFFECTS ON ARTICULAR CARTILAGE OF EXPERIMENTAL INTRA-ARTICULAR ^{198}Au INSTILLATIONS. Rubin, Philip; Casarett, George; Farrer, Paul (Rochester Univ., N. Y. Dept. of Radiation Therapy). [1967]. 12p. (CONF-691233-1; CONF-700610-15). Dep. NTIS.

From Roentgen Ray Society of North America conference; Chicago, Ill. (Dec 1969).

Radiation-induced damage of articular cartilage occurred only in weanling rats at extremely high dose levels, i.e., 2.5 mCi and 5.0 mCi. Adult articular cartilage is extremely resistant to radiation damage and to high doses of ^{198}Au instillations, i.e., 5.0 mCi and 10.0 mCi. The experimental evidence suggests that a safety factor of 100 x to 1,000 x exists in its clinical usage. (auth)

31374 CELL POPULATION KINETICS IN THE SEMINIFEROUS EPITHELIUM UNDER LOW DOSE IRRADIATION. Fabrikant, Jacob I. (Univ. of Connecticut, Hartford). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 114: No. 4, 792-802 (Apr 1972).

Under continuous low dose irradiation following the uptake of ^{3}H-thymidine, cell renewal in seminiferous epithelium during spermatogenesis in the mouse achieved a near steady state of cell population at a dose rate of 1.8 rads per day or less for at least 15 weeks by limited mechanisms of compensatory cell proliferation. Changes in the patterns of spermatogonial cell population kinetics indicated that there was some reserve of proliferative capacity, but the extent to which these changes were due to decreasing the cell cycle time of a precursor subpopulation in the type A cell compartment was not clear. (C.H.)

31375 STUDIES ON BONE TISSUE REGENERATION UNDER THE ACTION OF ^{89}Sr IN LOW DOSES, PRIOR TO AND AFTER DECORPORATION. Sivchev, S.; Krustanov, D. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 139-48(1967).

The effect of the incorporation of a single low dose (20 μCi) of ^{89}Sr on bone regeneration was studied in rats. The effect of decorporation treatment was also studied. The animals were divided into three treatment groups as follows: intact controls; animals receiving intraperitoneal injection of ^{89}Sr; and animals receiving ^{89}Sr plus decorporation treatment. Decorporation treatment consisted of dehydration, vitamin B_1, and calcium β-glycerophosphate in doses of 1, 5, and 3 mg, respectively. Regeneration was observed at 15, 30, and 60 days following fracturing in all groups. It was concluded that low doses of ^{89}Sr stimulate regeneration quantitatively, but inhibit to some extent the processes of cell and tissue regeneration. Decorporation treatment contributed to reducing the effect of incorporated ^{89}Sr on qualitative transformations in the bone regenerates. (E.R.B.)

31376 POSTNATAL DEVELOPMENT AND GENETIC DAMAGE IN MICE RECEIVING ^{131}I TREATMENT IN FETAL LIFE. Bairakova, A. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 109-15 (1967).

The postnatal development and incidence of genetic damage in offsprings born to gravid mice receiving ^{131}I treatment 16 days after conception were studied. The amount of ^{131}I administered corresponds to the highest therapeutic doses. Postnatal development was followed in respect to mortality, gross anomalies, and mean body weight on postnatal days 5, 15, and 30. Animals surviving to reproductive maturity were mated to normal mice and the postimplantation survival of embryos was determined as an indication of the incidence of dominant lethal mutations in the ^{131}I-treated mice. It was concluded that ^{131}I incorporation by fetuses on day 16 of gestation results in high postnatal death, general retardation of growth, and nanism. Based on the criterion used, it was also concluded that marked genetic damage was induced in the fetus as a result of the administration of ^{131}I. (E.R.B.)

31377 BONE-MARROW CELL CHROMOSOME ABERRATIONS IN MICE RECEIVING ^{131}I OR ^{32}P TREATMENT IN PRENATAL LIFE. Todorov, S.; Baev, I.; Ivanov, B.; Bairakova, A. Sci. Publ. Res. Inst. Radiol. Radiat. Hyg.; 3: 95-100(1967).

Chromosome anomalies in bone-marrow cells from 9-month-old mice treated on day 12 of embryonic life with ^{131}I or ^{32}P were studied. Clinical application of these isotopes is spreading. The amount of activity used in the present experiments, 60 μCi/gravid mouse, normalized to grams of body weight, is of the order of the largest therapeutic doses. In a 12-day mouse embryo, organs and systems have been formed and radioresistance is relatively high. (auth)

31378 LUNG ADENOMATOSIS AND ADENOMAS IN RATS TREATED WITH THOROTRAST. Grampa, G.; Cefis, F.; Di Ferrante, E. R. (Univ., Milan. CCR-EURATOM, Ispra, Italy). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 595-8(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

In 10 out of 33 Sprague-Dawley's rats treated intravenously with 1, 2, or 3 cm^3 of Thorotrast, at the age of 107 ± 10 days and sacrificed from 296 to 681 days after the treatment, adenomas and areas of adenomatosis were observed in the lungs. A dose-effect response was apparent in rats treated with 3 cm^3 of Thorotrast. No adenomatosis was found in 57 control animals. The role of ^{232}Th and of its daughter products in the development of pulmonary lesions is discussed. (auth)

Nuclide Kinetics and Toxicology

Refer also to abstract 30853.

31379 MATHEMATICAL MODEL OF RADIOISOTOPE ACCUMULATION AND ELIMINATION BY LIVING ORGANISMS. Paskalev, Z. Sci. Publ., Res. Inst. Radiol. Radiat. Hyg.; 3: 73-6(1967).

A mathematical model is proposed for the processes of radioisotope accumulation and elimination by living organisms. All terms used in the derivation of the model are defined. (E.R.B.)

Man

31380 COMPARISON BETWEEN TRITIUM CONCENTRATION IN DRINKING WATER AND BODY WATER. Moghissi, A. A.; Lieberman, R. (Western Environmental Research Lab., Las Vegas, Nev.). Health Phys.; 22: No. 5, 509-11(May 1972).

A study was made of the relationship between the tritium concentration in the body water and the drinking water in Beaufort, South Carolina, downstream from the Savannah River plant in Aiken, S. C. Monthly urine and drinking water sampling was carried out by 6 healthy adults between March 1968 and June 1969. Agreement between the analytical results of water samples collected on the same day was within the expected sampling and analytical errors. However urine concentrations varied substantially between different subjects. The average activity for the drinking water for the sampling period was 5.6 nCi/l.; the average for urine samples was 2.4 nCi/l.; giving a ratio between drinking water and body water of 1 : 0.4. (UK)

Animals

31381 (NP-19251) ^{85}Kr: A REVIEW OF THE LITERATURE AND AN ANALYSIS OF RADIATION HAZARDS. Kirk, William P. (Eastern Environmental Radiation Lab., Montgomery, Ala. Environmental Protection Agency, Rockville, Md. Office of Research and Monitoring). Jan 1972. 60p. NTIS.

Information on ^{85}Kr is summarized. Major subject areas covered include: physical, chemical and radiological data; the maximum permissible concentration in air $(MPC)_a$ and its rationale; source data; atmospheric concentrations and dose estimates near reprocessing facilities and worldwide; proposed control methods; uses in science, especially medicine and industry; calculations of dose to various organs and their relationship to the $(MPC)_a$; unexplained noble gas phenomena; and methods of sampling and analysis. The tissue distribution kinetics of ^{85}Kr in rats were studied and results are discussed in detail. Preliminary desaturation curves obtained with rats are presented. (234 references) (auth)

31382 SEASONAL CONCENTRATION, TURNOVER, AND MODE OF ACCUMULATION OF ^{32}P BY THE JUVENILE STARRY FLOUNDER PLATICHTHYS STELLATUS (PALLAS) IN THE COLUMBIA RIVER ESTUARY. Bolen, John Joseph. Corvallis, Oreg.; Oregon State Univ. (1972). 152p. University Microfilms Order No. 72-12,516.

Thesis.

The seasonal concentration, turnover, and mode of accumulation of ^{32}P by the juvenile starry flounder in Alder Slough, a small ecosystem in the Columbia River Estuary, was examined during 1969 and 1970. Levels of ^{32}P and concentrations of total P were measured to permit computation of specific activities (nCi^{32}P/g total P). (Diss. Abstr. Int., B)

31383 TWO STAGE LIVER AND BONE SCANS WITH SINGLE DOSE OF ONE ISOTOPE. Chaudhuri, Tapan K.; Chaudhuri, Tuhin K.; Christie, J. H. (Univ. of Iowa, Iowa City). Int. J. Appl. Radiat. Isotop.; 23: No. 4, 204-5(Apr 1972).

Since inorganic phosphate, administered intravenously to rats preinjected with radiostrontium, forms a colloid of strontium phosphate, which has high uptake in the liver followed by gradual release into the circulation from where ionic strontium is taken up by the bone by the process of heterionic exchange, an investigation was made to see if a single dose of preformed (in vitro) ^{87m}Sr-phosphate would have a better liver uptake initially and could thus be used for consecutive liver and bone scans. The preliminary results of these tests are given from which it is shown that clinically it is acceptable and with the short $T^{½}$ of 2.8 hr, an acceptable major γ energy of 390 keV, ready availability from a ^{87}Y generator, and easy producibility of the complex, the physical characteristics are also attractive. (UK)

31384 ^{210}Po ABSORPTION IN RATS: EFFECTS OF BIOLOGICAL MODIFICATION. McInroy, J. F.; Watters, R. L.; Johnson, J. E. (Colorado State Univ., Fort Collins). Nature (London) New Biol.; 236: No. 65, 118-20(29 Mar 1972).

Groups of rats were fed the following solution/suspensions: $^{210}PoCl_4$ in 0.03N HCl; $^{210}PoO_2$ dissolved in filtered deionized water; goat's milk from an animal given an oral dose of 200 μCi of $^{210}PoO_2$; and normal drinking water. The daily intake of ^{210}Po was estimated for 8 days, when the animals were sacrificed and calculations made of the retained percentage of ingested ^{210}Po/g wet weight of the following tissues: spleen, liver, kidney, heart, and blood. There was no significant difference in the absorption of the oxide and chloride forms of ^{210}Po. The ratio of activity in the tissues of milk fed rats to that in the oxide and chloride fed rats was approximately 20 for all tissues except the liver, where it was between 4 and 5. It was estimated that in the milk-fed rats, all the activity was in the circulating blood, liver, and kidneys. Results indicated that in the milk fed group, 0.489 of the ingested ^{210}Po was retained at the time of death and the fraction of radioisotope absorbed across the gut was 0.504, a figure eight times that used by the ICRP in calculations of maximum permissible body burdens. (UK)

31385 DETERMINATION OF THE OXYGEN ENHANCEMENT RATIO FOR ^{252}Cf USING CULTURED MAMMALIAN CELLS. Hall, Eric J.; Phil. D. (Columbia Univ., New York). Brit. J. Radiol.; 45: No. 532, 284-8(Apr 1972).

Chinese hamster cells in culture were used as a biological test system to measure the oxygen enhancement ratio (OER) for the mixed neutron and γ ray emission from ^{252}Cf. The cells were irradiated in suspension in sealed glass ampoules. Ampoules containing 10^6 cells in 1 ml became hypoxic within two hr of being sealed. Ampoules containing 10^3 cells remained aerated for at least 26 hr which was the longest exposure used in the Cf experiments. The OER measured with this system was found to be 1.4, with 95% confidence limits of 1.25 and 1.55. (UK)

31386 ^{232}Th DISTRIBUTION IN RATS INJECTED WITH THOROTRAST. Di Ferrante, E. R.; Grampa, G. (EURATOM-CCR, Ispra, Italy). Med. Nucl.-Radiobiol. Lat., Suppl.; No. 3, 568-74(1968). (In Italian).

From ninth national conference of the Italian Association of medical radiobiology; Varese, Italy (20 Sep 1968).

The content of ^{232}Th in organs of rats injected with different amounts of Thorotrast (colloidal ThO_2) and sacrificed at different times was determined by alpha-spectrometry. The thorium localized in the organs appeared uniformly distributed and the concentrations obtained were unaffected by the time elapsed between treatment and sacrifice. The total uptake in liver varied from 18 to 48% of the injected thorium, in spleen from 5 to 25%, and in lungs from 0.05 to 0.5%. Great variations in the concentrations and nonuniform distribution of ^{232}Th were observed in bone marrow and tumor tissues. (auth)

New Tracer Techniques

Refer also to abstract 30618.

31387 MEASUREMENT OF CARDIAC OUTPUT IN RATS BY ^{125}I DILUTION. Cotton, R. T.; Mugashe, F. L.; Gallie, B. L.; (and others) (Mount Sinai Hospital, Toronto. Univ. of Toronto). Can. J. Physiol. Pharmacol.; 49: No. 12, 1019-22(Dec 1971).

A simple, rapid, indicator-dilution method of estimating cardiac output in small animals using ^{125}I human serum albumin was developed. The variation of repeat determinations in a single animal was ±10%. The cardiac output in normotensive 250-350 g Wistar male rats was 217 ± 28 (±S.D.) ml/kg min^{-1}. These results agree with others derived by more tedious methods. After the mean arterial blood pressure was reduced to 50 mm Hg for 60 min by hemorrhage the cardiac output declined to 104 ± 40 ml/kg min^{-1}. With this method it is possible to repeat determinations of cardiac output during shock. (auth) (Canada)

31388 STUDIES ON DEVELOPMENT OF A RAPID BACTERIOLOGICAL TEST UTILIZING RADIOISOTOPE ^{32}P FOR ENUMERATING WATER BACTERIA. Khanna, P.; Mathur, R. P.; Saraswat, I. P. (Univ. of Roorkee, India). pp 383-7 of proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.2).

The relationship between added carrier phosphorus ^{32}P and total phosphorus uptake by Escherichia coli cells was used as a rapid bacteriological test for enumerating water bacteria. The reproducibility and reliability of the test (called modified coprecipitation technique) was compared with the conventional microfilter test for bacterial species of public-health importance. (auth)

31389 NEW METHOD OF MEASURING BLOOD FLOW BY IN VIVO ACTIVATION OF BLOOD OXYGEN USING NEUTRON IRRADIATION. Auphan, Michel; Perilhou, Jean; Spaa, Henri. Compt. Rend., Ser. D; 273: No. 21, 1995-7(22 Nov 1971). (In French).

This new method improves the quality of the information provided by classical radiocardiography with injection of radioelements and avoids any surgery. The heart is irradiated with neutrons, the following reaction taking place $^{16}O(n,p) \rightarrow {}^{16}N$; 6 MeV γ irradiation is produced. The method assures the complete dilution of the indicator in the cardiac cavities, as it is the oxygen of the blood water that is transformed into ^{16}N. The method may be applied to measure the blood flow in other organs. (France)

MATERIALS

Ceramics and Cermets

Refer also to abstracts 30668, 30852, 30890, 30892–30894, 31038, 31039, 31448, 31482, 31487, 31496, 31497, 31531, 31569, 32619, 32666, 32669, 32670, 32681, 32716, 32750, 32791, and 32937.

31390 (ANL–7901) THERMODYNAMIC AND DEFECT-STRUCTURE STUDIES IN MIXED-OXIDE FUELS. Javed, N. A.; Roberts, J. T. A. (Argonne National Lab., Ill.). Feb 1972. Contract W-31-109-eng-38. 22p. Dep. NTIS.

Transpiration experiments were performed at 1000 to 1700°C to study the thermodynamics and defect structure of hypostoichiometric UO_2–20 wt % PuO_2. The oxygen partial pressures were established by using flowing H_2/H_2O mixtures. After equilibration, the quenched products were analyzed by chemical, x-ray, neutron-diffraction, and metallographic techniques. The principal thermodynamic functions $\Delta\bar{G}_{O_2}$, $\Delta\bar{H}_{O_2}$, and $\Delta\bar{S}_{O_2}$ were calculated between 1400 and 1700°C for various oxygen-to-metal ratios. Based on x-ray, neutron-diffraction, and metallographic data, it was concluded that the 20 wt % mixed oxide exists as a single phase under normal conditions, even at an oxygen-to-metal ratio as low as 1.92. The data from density measurements and neutron-diffraction analysis indicated that the predominant defects in the hypostoichiometric UO_2–20 wt % PuO_2 are anion vacancies. The curves of $\Delta\bar{G}_{O_2}$ versus temperature for the mixed oxide with different oxygen-to-metal ratios were compared with $\Delta\bar{G}_{O_2}$ curves for various metal oxides, and possible interactions among fuel, cladding, fission product, and coolant were established. (auth)

31391 (ARH–470) LABORATORY STUDIES OF MIXED-OXIDE POWDER PREPARATION BY CONTINUOUS AMMONIA PRECIPITATION. Curtis, M. H. (Atlantic Richfield Hanford Co., Richland, Wash.). 1 Apr 1968. Contract AT(45-1)-2130. 38p. Dep. NTIS.

Studies are continuing on the continuous coprecipitation of uranium diuranate–plutonium hydroxide by ammonia of a product that would meet powder quality specifications. The goal was twofold: to achieve a high filtration rate for the slurry (relative to plutonium oxalate, and in the same type of continuous precipitator) on a vacuum drum filter; and to achieve satisfactory hydrogen reduction in a continuous vibrating tube reactor so as to give acceptable powder properties. Experimental work in laboratory and prototype equipment established that the existing plutonium finishing equipment has the potential of producing mixed oxides by the ammonia coprecipitation process. Continuous precipitation of a slurry suitable as feed for a continuous drum filter is possible by using close pH control and elevated temperature. Continuous hydrogen reduction may be achieved in a vibrating tube reactor if the equipment is capable of providing suitable temperatures, gas flow rates, and residence times. By following the techniques developed, the product oxide physical and chemical properties are suitable for fuel fabrication. (M.C.G.)

31392 (CONF-701105–, pp 317-28) ANALYSIS OF SPHERICAL COATINGS ON NUCLEAR FUEL PARTICLES. Prados, John W.; Roland, Hall C. (Tennessee Univ., Knoxville). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

Development of coated-particle fuels for high-temperature gas-cooled reactors has prompted the formulation of mathematical models which permit estimation of the operating life of pyrolytic carbon- and/or silicon carbide-coated nuclear fuel microspheres. Although such models are of limited utility in a priori failure predictions, they are of significant value in the planning and interpretation of irradiation tests of such fuels, and in extrapolating test data to new operating conditions. These models vary in complexity and generality, but commonly involve analysis of the particle coating as a multilayer spherical pressure vessel, subjected to loading from internal fission-gas pressure, fuel swelling, and the shrinkage and anisotropic distortion of coating materials resulting from fast-neutron damage. Failure is predicted to occur when some selected function of the coating stress and/or strain exceeds a specified minimum value. Such an analysis is presented for two-layer spherical pyrolytic-carbon shells surrounding microspheres of $(U,Th)C_2$ or $(U,Th)O_2$. These coatings may be anisotropic and exhibit significant creep under fast-neutron irradiation, and an iterative numerical technique is employed in determining the distribution of coating stresses and strains. Results were found to be rather sensitive to the magnitude of radioinduced dimensional changes and creep assumed for the coatings. However, comparisons between model predictions and the results of coated-particle irradiation and annealing experiments have been generally encouraging. (auth)

31393 (CONF-710118) PROCEEDINGS OF THE SYMPOSIUM ON POWDERS AND SINTERED PRODUCTS, INDIAN INSTITUTE OF TECHNOLOGY, KANPUR, JANUARY 31–FEBRUARY 1, 1971. (Department of Atomic Energy, Bombay (India). Chemistry and Metallurgy Committee). 284p.

Seventeen articles are included; a separate abstract was prepared for each of 12. The remaining five articles contain information on: direct reduction technique—a new approach to production of certain metal powders; the present status of sintering theories in crystalline materials; explosive compaction of metal powders; tin oxide ntc resistors for low-temperature measurements; and stainless steel fiber-reinforced aluminum composites. (P.C.H.)

For abstracts of individual papers see: 31440–31446, 31483–31486, and 31554.

31394 (CONF-720420–1) IRRADIATION BEHAVIOR OF BORON CARBIDE. Copeland, G. L.; Donnelly, R. G.; Martin, W. R. (Oak Ridge National Lab., Tenn.). [1972]. 31p. Dep. NTIS.

From Conference on reactor materials performance; Richland, WA. (24 Apr 1972).

Boron carbide is the prime candidate material for neutron absorbers in fast breeder reactors and the Fast Test Reactor. Important data required for design of control rods for these reactors are swelling, gas release, and structural integrity of boron carbide under the expected operating conditions. Data from irradiations of boron carbide powders in a thermal reactor and powders and pellets in a fast flux reactor are presented. These data are interpreted and discussed in terms of expected performance in a fast reactor. The most important variable in determining irradiation behavior appears to be the mobility of the helium produced relative to the rate it is produced. This precludes extrapolation of data obtained in thermal reactors to predict performance in fast reactors. It was concluded that the only accurate way to predict the performance of boron carbide pellets in a fast reactor is to conduct irradiation tests for the same temperatures, times, and burnup levels expected in service. (auth)

31395 (CONF-720420–3) POROSITY AND ACTINIDE REDISTRIBUTION DURING IRRADIATION OF $(U,Pu)O_2$. Lackey, W. J.; Homan, F. J.; Olsen, A. R. (Oak Ridge National Lab., Tenn.). [1971]. 62p. Dep. NTIS.

From Conference on reactor materials performance; Richland, WA. (24 Apr 1972).

Thermal-gradient-induced redistribution of porosity and fuel components during irradiation of $(U,Pu)O_2$ will alter the fuel thermal conductivity, melting point, mechanical properties, and radial heat generation profile sufficiently to influence fast breeder reactor fuel pin performance. Analytical models, which should prove useful in design and analysis of such fuel pins, were developed for predicting radial porosity and Pu: (U + Pu) profiles. The interrelated porosity and actinide redistribution models are kinetic and based on the evaporation–condensation mechanism of material transport. The models were shown to yield predictions in accord with experimentally measured porosity and actinide profiles for an irradiated pin containing stoichiometric fuel. The volume-averaged porosity of the columnar grain region of irradiated pins was 5.9 and ≥3.8% after burnups of 0.7 and 4.2% FIMA, respectively. The columnar grains are thus more porous than previously believed. (auth)

31396 (COO–1198-880) THERMODYNAMIC STUDY OF ORDER–DISORDER TRANSITIONS IN VANADIUM CARBIDE. Emmons, George Herbert (Illinois Univ., Urbana). Feb 1972. Contract AT(11-1)-1198. 167p. Dep. NTIS.

Differential thermal analysis was used to measure the thermodynamic properties of V_6C_5 and V_8C_7 at the order–disorder transitions of their respective carbon sublattices. The critical temperatures and enthalpy increases due to disordering were determined to be: 1250 ± 2°C and 6.65 cal/g ± 2.90 cal/g for V_6C_5 and 1152 ± 2°C and 7.04 cal/g ± 3.07 cal/g for V_8C_7. The Bragg–Williams approximation was adapted to the carbon sublattice of V_6C_5 and was used to estimate properties of the order–disorder transition. An enthalpy increase due to disordering of 8.75 cal/g was predicted using the critical temperature determined by DTA and the B–W approximation. The temperature range over which disordering is observable in V_6C_5 powders using DTA is smaller than predicted by B–W but in good agreement with the temperature range over which the effects of disordering are observable through resistivity changes in single crystal samples. The additional enthalpy increase of V_6C_5 below T_c is 33% of the total additional enthalpy increase of the transition. The latent heat of the transition $V_6C_5 + VC_{0.83}$ is 3.3 ± 1.0 cal/g. The behavior of the isobaric specific heat below the critical temperature is consistent with a critical behavior described by $C_V = A \ln |\epsilon| + B$. Compositions of the V−C system between the compounds V_6C_5 and V_8C_7 (VC_x, $0.833 < x < 0.875$) undergo transitions at the critical temperatures of V_6C_5 and V_8C_7. The ratio of the enthalpies of these two transitions is in good agreement with a ratio predicted from the carbon-to-metal ratio of these compositions, x, assuming that they are mixtures of the ordered compounds V_6C_5 and V_8C_7. (auth)

31397 (EURFNR–964) CONTRIBUTION TO THE URANIUM MONOCARBIDE–TUNGSTEN SYSTEM. Politis, C. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Translation of report KFK–1464. 13p. Dep. NTIS.

Work performed under United States–Euratom Fast Reactor Exchange Program.

The uranium monocarbide–tungsten system was studied using metallographic and x-ray methods as well as microprobe and electron microscope analyses. The peritectic reaction has been confirmed and the peritectic temperature was found to be 2170° ± 10°C. Close to the peritectic line the solubility of tungsten in uranium monocarbide is of about 5 wt % W. The observed UWC_{2-x} phase has a monoclinic structure isomorphous with the $UMoC_{1.7}$ phase and has the following lattice parameters: a = 5.624 ± 0.002 Å, b = 3.240 ± 0.001 Å, c = 11.640 ± 0.003 Å, and $\beta = 109.6 \pm 0.1°$. The solubility curve of W in UC is given. UC with a small percentage tungsten seems to be chemically more stable than pure UC. (auth)

31398 (EURFNR–996) COMPATIBILITY BEHAVIOUR OF OXIDE AND CARBIDE FUELS WITH CLADDING MATERIALS. Goetzmann, O.; Hofmann, P. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Jan 1972. 20p. (KFK–1546; CONF-711215–1). Dep. NTIS (U. S. Sales Only).

From GCFR fuel specialists meeting; Harwell, England (16 Dec 1971).

The compatibility behavior of oxide and carbide fuels with claddings of austenitic steels and vanadium-base alloys is described. Even though many out-of-pile investigations with oxide fuels and steel clads showed good compatibility, strong cladding attacks occurred in irradiation tests. This differing behavior was caused by the changes the fuel undergoes during burnup. The changes themselves are dependent on the ratio of the fission isotopes in the fuel. This has consequences on the post irradiation evaluation. According to thermochemical data, the compatibility between vanadium alloys and a U–Pu–mixed oxide fuel is bad. Out-of-pile investigations have shown heavy embrittlement at room temperature of vanadium claddings after reaction with mixed oxide fuels. However, there is a chance that the oxygen uptake does not cause embrittlement at higher temperatures. Carbides fuels are not in a thermodynamic equilibrium with claddings of stainless steels or vanadium alloys. Compatibility tests up to 800°C showed still good compatibility between several types of steels and slightly hyperstoichiometric carbide. The reactions with some vanadium alloys are still slower, hence good compatibility can also be assumed between vanadium-base alloys and carbide fuels up to temperatures of 800 or even 900°C. Embrittlement by carbide reaction is less severe than with oxide. (auth)

31399 (N–72–14795) HYDROGEN PLASMA TESTS OF SOME INSULATING COATING SYSTEMS FOR THE NUCLEAR ROCKET THRUST CHAMBER. Current, Arthur N.; Grisaffe, Salvatore J.; Wycoff, Kurt C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan 1972. 55p. (NASA-TM-X-2461; E-6565). NTIS.

Plasma-sprayed and slurry-coated insulating coating systems were evaluated for structural stability in a low-pressure hot hydrogen environment at a maximum heat flux of 19.6 million watts/m². The heat was provided by an electric-arc plasma generator. The coating systems consisted of a number of thin layers of metal oxides and/or metals. The materials included molybdenum, nichrome, tungsten, alumina, zirconia, and chromia. Results of the study indicate the potential usefulness in this environment for a number of the coatings, and point up the need for improved coating application techniques. (auth) (STAR)

31400 (NRL–7371) STRESS-CORROSION CRACKING OF HIGH-STRENGTH STEELS AND TITANIUM ALLOYS. Judy, R. W. Jr.; Goode, R. J. (Naval Research Lab., Washington, D. C.). 23 Nov 1971. 32p.

One of the major problems of metal structures in the seawater environment is the growth of flaws by the stress-corrosion-cracking (SCC) mechanism. Environmental effects on the integrity of the structure are related both to SCC processes and to the inherent tolerance of the material for flaws at regions of high stresses. The Ratio Analysis Diagram (RAD) provides translations of fracture resistance properties of metals to expected structural performance; the RAD has been modified to include analyses of the effects of SCC. The significance of section-size effects on the results of SCC tests based on linear-elastic analysis methods and expected structural behavior are included on the modified diagram, which is called the Dual-SCC RAD. Examples of several current high-strength steels and titanium alloys are referenced to the Dual-SCC RAD to illustrate its use. (auth)

31401 (ORNL–4755) CONVERSION OF URANIUM NITRATE TO CERAMIC-GRADE OXIDE FOR THE LIGHT WATER BREEDER REACTOR: PROCESS DEVELOPMENT. Leitnaker, J. M.; Smith, M. L.; Fitzpatrick, C. M. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 54p. Dep. NTIS.

A limited study was made of an "ADU" process to make UO_2 for use as fissile material dissolved in ThO_2. A factorial study of precipitation included measuring the effects of initial nitric acid content of uranyl nitrate, the temperature of precipitation, the final pH of the solution, and time of digestion on the composition of the uranate cake and the surface area and tap density of the final powder. Studies of drying measured the effect of time, temperature, and grinding of the yellow cake on the surface area and tap density of the final powder. Effects of temperature and time were studied on the composition and surface area of "UO_3" made by heating ammonium uranate in argon. Effects on surface area of the temperature of reduction of uranate in H_2 were studied. Factors affecting stabilization of UO_2 powder were also studied, and the mechanism causing ignition of UO_2 was elucidated. (auth)

31402 THERMAL EXPANSION, 1971. Symposium Held at Corning, N. Y., October 27–29, 1971. Graham, M. G.; Hagy, H. E. (eds.). AIP Conference Proceedings, Number 3. New York; American Institute of Physics (1972). 317p. (CONF-711033).

Thirty-three papers presented at the conference are included. A separate abstract was prepared for one paper. The remaining papers were not in the scope for NSA. (M.C.G.)

For an abstract of an individual paper see: 31403.

31403 VARIATION OF LATTICE PARAMETER OF UC–ZrC SOLID SOLUTIONS WITH TEMPERATURE AND COMPOSITION. Bowman, A. L.; Krikorian, N. H.; Nereson, N. G. (Los Alamos Scientific Lab., N. Mex.). pp 119-30 of Thermal Expansion, 1971. /Graham, M. G. (ed.). New York; American Inst. of Physics (1972).

From third thermal expansion symposium; Corning, N. Y. (27 Oct 1971).

The variation of lattice parameter of uranium carbide–zirconium carbide solid solutions with temperature was measured by high-temperature neutron diffraction. The cubic lattice parameter was determined from 800 to 2300°C for samples $(U_xZr_{1-x})C$ plus excess carbon, with x from 0 to 0.181. The lattice parameter of all the samples in this composition range can be approximated by the equation $a_t = a_{25}\,(1 + 6.6(3) \times 10^{-6}[t - 25] + 0.7(2) \times 10^{-9}[t - 25]^2)$ from room temperature to 2300°C. (auth)

31404 ABSORPTION OF HYDROGEN BY TITANIUM, ZIRCONIUM, AND NIOBIUM CARBIDES. Samsonov, G. V.; Morozov, V. V. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 8, 1891-3(Aug 1971).

Translated from Zh. Prikl. Khim.; 44: No. 8, 1872-4(Aug 1971).

Studies on the absorption of hydrogen by titanium, zirconium, and niobium carbides in the homogeneity as well as the two-phase region showed that the nature of absorption for all these carbides was similar and followed a parabolic law $y^n = k\tau$. Determination of the activation energy of the process made it possible to suggest that the change in the activation energy is associated with a change in the number of nonlocalized electrons in the carbides. (auth)

31405 INVESTIGATION OF PROCESSES OCCURRING DURING THE SYNTHESIS OF LEAD-CONTAINING ZIRCONIUM–TITANIUM CERAMICS. Freidenfel'd, E. Zh.; Yanson, G. D.; Shitpa, D. A.; Maksimova, O. S. pp 124-30 of Eksperimental'noe Issledovanie Mineraloobrazovaniya. /Nasedkin, V. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

The modifying influence of Bi_2O_3, WO_3, and complex Bi-containing additions on the formation processes of lead titanate, zirconium titanate, and their solid solutions, such as may be represented by $Pb(Zr_{0.55}Ti_{0.45})O_3$ is discussed. The activation energy of such processes ranged from 15.8 to 79.2 kcal/mole for a variety of initial oxide mixtures, e.g., $PbO-TiO_2$, $PbO-ZrO_2$, $PbO-ZrO_2$ + 3% Bi_2O_3, etc. (K.S.W.)

31406 MINERAL FORMATION IN REFRACTORIES FROM ZrO_2. Gul'ko, N. V.; Karaulov, A. G.; Sudarkina, T. E. pp 373-8 of Eksperimental'noe Issledovanie Mineraloobrazovaniya. /Nasedkin, V. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

The phase composition of ZrO_2 samples was studied after treatment of the monoclinic and stabilized cubic forms (6% CaO) of ZrO_2 with P_2O_5. The temperature dependence of the destabilization process of a cubic solid solution of ZrO_2 and the formation of Zr and Ca phosphates in samples with varying P_2O_5 content are discussed. Optical constants were measured for $(ZrO)_2P_2O_5$ and $CaZrP_2O_8$ and similar phases related to the $CaO-ZrO_2-P_2O_5$. (tr-auth)

31407 NUCLEAR FUEL PARTICLES. Goeddel, Walter V. (to United States Atomic Energy Commission). U. S. Patent 3,650,896 21 Mar 1972. Filed 9 Oct 1969.

Nuclear fuel particles having fissile or fertile central cores surrounded by a buffer layer of low density pyrolytic carbon are described. A shell of dense silicon carbide, zirconium carbide or niobium carbide surrounds the buffer layer, and a layer of isotropic pyrolytic carbon may be disposed between. To maintain the dense carbide shell in compression during the fuel particle lifetime, an outer isotropic carbon shell is provided which shrinks down onto the carbide shell as a result of high temperature, fast neutron irradiation. To prevent stresses of too great a magnitude from being created early in the fuel particle lifetimes, an intermediate layer of compressible pyrolytic carbon is disposed immediately exterior of the carbide shell. Nuclear reactors utilizing such particles can be operated at temperatures about 800°C to a fast neutron dosage over 4×10^{21} neutrons/cm^2 while maintaining good fission product retentivity within the coated fuel particles. (Official Gazette)

31408 NUCLEAR REACTOR FUEL COATED PARTICLES. Chin, Jack; Luby, Charles S.; Mills, Richard G. (to United States Atomic Energy Commission). U. S. Patent 3,649,452. 14 Mar 1972. Filed 28 Mar 1968.

A process is described for producing coated nuclear fuel particles having improved fission product retention by applying a low density pyrolytic carbon layer, followed by a dense silicon or zirconium carbide layer, and thereafter a dense isotropic pyrolytic carbon layer. A thin seal layer of an impermeable pyrolytic carbon is deposited between the low density carbon and the metal carbide layer. For certain cases, and particularly where oxide fuel particles are employed, an additional seal layer of an impermeable pyrolytic carbon is deposited immediately adjacent the nuclear fuel core. Further, the particles may include a layer of dense isotropic pyrolytic carbon deposited interior of the metal carbide layer. The exterior dense isotropic layer should have a thermal coefficient of expansion, which approximates that of the metal carbide within about 20% such that the metal carbide is maintained in compression under subsequent irradiation. (Official Gazette)

31409 OXIDE TREATMENT OF TUNGSTEN CARBIDE TOOLS AND ITS INFLUENCE ON MASS DIFFUSION AND TOOL LIFE. Suh, Nam P. (Massachusetts Inst. of Tech., Cambridge); Naik, Subhash K. J. Eng. Ind.; 93: No. 4, 1106-12(Nov 1971).

The role of oxide layers on tungsten carbide tools in metal cutting was investigated using oxide-treated tools. It is shown that the structural change of the subsurface of the tool takes place due to mass diffusion between the oxide and the substrate, which enhances the metal cutting properties of tungsten carbide tools. The tools were coated with titanium dioxide and heated in a vacuum of 10^{-4} torr. These oxide-treated tools and the untreated tools were diffusion-bonded to steel in a vacuum so as to determine the influence of the oxide treatment on mass diffusion. The changes in the hardness of these bonded specimens were measured after maintaining them at high temperatures for various durations. The hardness across the interface of the bonding changed sharply in the case of the untreated tools, the hardness of steel increasing and that of tungsten carbide decreasing. In the case of the oxide-treated tools, the hardness did not change appreciably. Cutting experiments showed that the cutting force and the crater wear decreased by about 12 to 20 percent after the oxide treatment. (auth)

31410 WEAR OF GRINDING WHEELS. PART 1. ATTRITIOUS WEAR. Malkin, S. (Univ. of Texas, Austin); Cook, N. H. J. Eng. Ind.; 93: No. 4, 1120-8(Nov 1971).

An investigation of attritious wear of grinding wheels in precision operation is described. Attritious wear refers to the dulling of the abrasive grain due to rubbing against the workpiece surface. The amount of dulling, measured by the area of the wear flats on the surface of the wheel, is found to be directly related to the grinding forces. In general, both the vertical and horizontal grinding force components increase linearly with the wear flat area. This is explained by considering the grinding force as the sum of a cutting force due to chip formation and a sliding force due to rubbing between the wear flats and workpiece. Related studies of wheel dressing, surface finish, and workpiece burn are also presented. (auth)

31411 INTERNAL FRICTION IN THE NIOBIUM-HYDROGEN SYSTEM. Baker, Craig Carlton. Urbana, Ill.; Univ. of Illinois (1971). 111p. University Microfilms Order No. 72-12,081. Thesis.

The diffusional behavior of hydrogen in niobium was investigated in the temperature range 20 to 273°K using internal friction techniques. Relaxations due to two types of hydrogen complexes were observed: hydrogen pairs and oxygen (or nitrogen)—hydrogen pairs. The hydrogen pair was shown to have an enthalpy of motion of 1265 cal/mole and an enthalpy of binding of 1490 cal/mole. The oxygen (or nitrogen)—hydrogen pair was shown to consist of a single hydrogen atom bound to the oxygen interstitial with an enthalpy of about 2000 cal/mole. The hydrogen motion enthalpy in the strain field of the oxygen atom was 3800 cal/mole. The "cold work damping peak" due to hydrogen moving in the strain field of a dislocation was observed and interpreted. A dislocation-hydrogen binding enthalpy of about 7300 cal/mole was determined. The solvus line for the Nb—H system was studied using the internal friction techniques and good agreement was obtained with the higher temperature phase diagram solubility. The techniques allow the solvus line to be determined at very low temperatures. A variation of the enthalpy of solution of the hydride with temperature was noted and studied. (Diss. Abstr. Int., B)

31412 GROWTH KINETICS OF INERT-GAS BUBBLES IN POLYCRYSTALLINE SOLIDS. Markworth, Alan J. (Battelle Memorial Inst., Columbus, Ohio). J. Appl. Phys.; 43: No. 5, 2047-52(May 1972).

Growth kinetics of inert-gas bubbles in polycrystalline solids were studied analytically. Growth is assumed to be gas-diffusion controlled, and coupled expressions were derived for the instantaneous rates of growth of bubbles situated both within grains and on grain boundaries. Numerical solutions of these expressions are obtained for given values of various parameters using a Runge—Kutta technique, and the results obtained in this manner were consistent with corresponding experimental data describing bubble growth in neutron-activated and annealed UC. In addition, approximate solutions to the coupled growth equations were obtained analytically for a special case and found to be in relatively good accord with corresponding results obtained numerically. (auth)

31413 CHROMIUM URANIUM OXIDES. Aravamudan, G.; Sampath, S. (Indian Inst. of Tech., Madras). pp 313-19 of Proceedings of the Chemistry Symposium, 1970. Vol. I. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.1).

The sequential changes of phases in the thermal decomposition of $UO_2CrO_45.5H_2O$ in air were: $UO_2CrO_45.5H_2O \rightarrow UO_2CrO_45H_2O \rightarrow UO_2CrO_42H_2O \rightarrow UO_2CrO_4 \rightarrow CrUO_{4.35} \rightarrow CrUO_4$. The nonstoichiometric $Cr^{III}UO_{4.35}$ was orthorhombic with a = 6.34 b = 3.70 and c = 3.87 Å. On its hydrothermal treatment, two other crystalline phases $Cr^{III}U(OH)_2O_{3.35}$ and $Cr^{III}U(OH)O_{3.85}$ were realized. $Cr^{III}UO_4$ was isostructural with pucherite, $BiVO_4$. Isothermal decompositions of UO_2CrO_4 into $CrUO_{4.35}$ and of the latter into $CrUO_4$ both followed unimolecular rate law with activation energies of 96 and 74 ± 2 kcal./mole, respectively. The ir and magnetic susceptibility measurements made gave additional evidences for the existence of different chromium(III) uranates. (auth)

31414 SURFACE AREA OF MOLYBDENUM TRIOXIDE. Venkataramana, P.; Krishnan, V. R. (Sri Venkatesware Univ. Chemical Labs., Tirupati, India). pp 131-6 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.2).

Specific surface area of molybdenum trioxide has been determined by isotopic surface exchange method using ^{99}Mo as tracer, and by Brunauer, Emmett and Teller's gas adsorption method using nitrogen as adsorbate, and by the microscopic method. The values obtained by each one of the three methods are found to be reproducible. The results of the three methods have been compared in the light of internal and external surface presented by molybdenum trioxide. (auth)

31415 THERMODYNAMIC PROPERTIES OF INDIUM NITRIDE. Vorob'ev, A. M.; Evseeva, G. V.; Zenkevich, L. V. (Moscow State Univ.). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 10, 1501-2(Oct 1971).

Translated from Zh. Fiz. Khim.; 45: No. 10, 2650(Oct 1971).

The vaporization of indium nitride was examined, the pressure of nitrogen over it was determined, and the heat and the entropy of formation were calculated. (auth)

31416 WETTING OF TaC BY LIQUID Cu AND LIQUID Ag. Rhee, S. K. (Bendix Corp., Southfield, Mich.). J. Amer. Ceram. Soc.; 55: No. 3, 157-9(Mar 1972).

Wetting of $TaC_{0\cdot97\pm0\cdot01}$ by liquid Cu and liquid Ag was studied by the sessile drop method. The cosine of the contact angle increased linearly with increasing temperature in both systems. The critical surface energy for spreading was 1098 $ergs/cm^2$ at 1605°C for Cu and 688 $ergs/cm^2$ at 2160°C for Ag. The work of adhesion, which was 1759 $ergs/cm^2$ at the melting point for Cu and 321 $ergs/cm^2$ at the melting point for Ag, increased parabolically with increasing temperature in both systems. The surface energy of $TaC_{0\cdot97\pm0\cdot01}$ was estimated to be 1804 ± 706 $ergs/cm^2$. (auth)

31417 STRUCTURE AND THERMOMECHANICAL PROPERTIES OF PARTIALLY STABILIZED ZIRCONIA IN THE CaO–ZrO_2 SYSTEM. Garvie, Ronald C.; Nicholson, Patrick S. (McMaster Univ., Hamilton, Ont.). J. Amer. Ceram. Soc.; 55: No. 3, 152-7(Mar 1972).

Partially stabilized zirconia (PSZ) ceramics in the system CaO–ZrO_2 were characterized. The microstructure, as revealed by optical microscopy, consisted of grains of pure ZrO_2 distributed in a matrix of fully stabilized material. Electron microscopy showed that the matrix grains have a complex substructure of 1000-Å domains of cubic and monoclinic ZrO_2. The grains appeared to fit Ubbelohde's concept of a hybrid single crystal. Evidence obtained indicated that the substructure provided an effective stress-relieving mechanism during thermal shock. It is proposed that initiation of phase inversion in pure ZrO_2 domains, even at subtransition temperatures (by thermal stresses), creates an extremely large microcrack density. On the basis of Hasselman's thermal-shock criterion, only quasi-static crack propagation occurs during thermal shock of PSZ; evidence is presented to support this concept. (auth)

31418 INFLUENCE OF POROSITY ON DEFORMATION AND FRACTURE OF UO_2. Roberts, J. T. A.; Ueda, Y. (Argonne National Lab., Ill.). J. Amer. Ceram. Soc.; 55: No. 3, 117-24(Mar 1972).

The effects of porosity on the deformation characteristics of sintered polycrystalline UO_2 were determined at 500, 1250°, and 1600°C at a strain rate of $\approx 0.1\ h^{-1}$. At 500°C, fracture was brittle and transgranular and initiated from the large pores present after fabrication. An increase in porosity from 5 to 16 vol % caused a 70% reduction in strength. At 1250 and 1600°C, plastic deformation preceded fracture, and the effect of porosity was much more complex. At 1250°C, an increase in porosity increased the strength but lowered the ductility, and the fracture mode changed from intergranular to transgranular. In contrast, at 1600°C porosity had little effect on strength. This behavior was associated with the relative magnitudes of the stress necessary to extend a preexisting flaw and the yield stress and their influence on the brittle-to-ductile transition temperature, T_c. (auth)

31419 STUDY BY ELECTRON MICROSCOPY OF THE POLYMORPHIC TRANSITION ReO_2(MONOCLINIC) → ReO_2(ORTHORHOMBIC). Colaitis, D.; Lecaille, C. (Laboratoire de Chimie des Solides, Paris). Mater. Res. Bull.; 7: No. 5, 369-80(May 1972). (In French).

Rhenium dioxide phase transition was studied from dehydration reaction of $ReO_2 \cdot 2H_2O$, under particular conditions. The microstructure of rhenium dioxide grains was analyzed by electron diffraction. When polymorphic transition monoclinic ReO_2 → orthorhombic ReO_2 takes place, planar ordered defects and streaking may be observed on the patterns of the two principal faces. A study of the defects was made, which suggests a transformation mechanism in accordance with crystallographic characteristics of ReO_2 and the existence of Re–Re bonding in this oxide. (auth)

31420 GRAIN GROWTH IN URANIUM OXIDE AT TEMPERATURES ABOVE 1500°C. Sheikh, Pervez A. (Pakistan Atomic Energy Commission, Karachi). Energ. Nucl. (Madrid); 16: No. 75, 39-46(Jan-Feb 1972). (In Spanish).

Grain growth was studied in uranium dioxide in the temperature range between 1500°C and the melting point. Factors affecting the grain growth as well as the mechanism that governs the process are discussed. (tr-auth)

31421 MECHANISM OF BINDERLESS GRANULATION AND GROWTH OF CERAMIC SPHERES. Ford, L. H.; Shennan, J. V. (Reactor Fuel Element Labs., Springfields, Eng.). J. Nucl. Mater.; 43: No. 2, 143-54(May 1972).

The mechanism by which highly spherical granules or seed spheres can be formed, and subsequently grown into larger spheres, from binderless sub-micron ceramic powders is described. The rate of formation and growth of these spheres is critically dependent on the shape of the constituent particles or crystallites of the powders and their surface characteristics. Also, in order to form highly spherical, monosized spheres the characteristics of the powder must allow interchange between the growing sphere and the powder. A simple technique for characterizing these submicron powders, with respect to their ability to form spheres, is suggested. (auth)

31422 ELASTIC PROPERTIES OF URANIUM MONONITRIDE AT 298 K. Guinan, M.; Cline, C. F. (Univ. of California, Livermore). J. Nucl. Mater.; 43: No. 2, 205-6(May 1972).

The single-crystal, adiabatic elastic constants of UN were determined at room temperature (298°K). Tabulated data are presented. (P.C.H.)

31423 TRANSFORMATION TO U_2C_3 PHASE IN UC–UC_2 AND UC_2 PHASES. Kurasawa, T.; Watanabe, H.; Kikuchi, T. (Japan Atomic Research Inst., Tokai). J. Nucl. Mater.; 43: No. 2, 192-204(May 1972).

Metallographic studies were carried out on the U_2C_3 transformation from uranium carbides characterized by the phase of the immiscibility region and Widmanstätten structure. The results showed that the U_2C_3 phase grew along Widmanstätten UC_2 congregating at an initial stage. The amount of U_2C_3 in the specimens having Widmanstätten structure was determined by the amount of Widmanstätten UC_2. The sintered pellet in the phase of the immiscibility region exhibited the consumption of herringbone UC for U_2C_3 transformation. Decomposition of UC_2 with excess carbon was found to be enhanced, compared with UC_2 without excess carbon. From the metallographic examination and x-ray study, the U_2C_3 phase was found to be transformed inward from the outer surface of the specimens. Rates of U_2C_3 transformation for the arc-melted and sintered specimens ($C/U \simeq 1/5$) are expressed by the following equations, respectively: $K = 0.40 \exp(-E_1/RT)\ cm^2 \cdot s^{-1}$; $K = 0.29 \exp(-E_2/RT)\ cm^2 \cdot s^{-1}$; $E_1 = 48.3 \pm 7.4$ kcal/mole; and $E_2 = 40.9 \pm 4.8$ kcal/mole. These phenomena are also considered to be related to the removal of the dissolved oxygen from UC_2 and to the carbon diffusion process. Microcracks and wrinkling of Widmanstätten UC_2 were observed, accompanied by volume contraction due to the U_2C_3 transformation. (auth)

31424 FORMATION OF U_2C_3 BY THE DECOMPOSITION OF URANIUM DICARBIDE. Schneider, F. H.; Naoumidis, A.; Nickel, H. (Kernforschungsanlage, Juelich, Ger.). J. Nucl. Mater.; 43: No. 2, 175-91(May 1972). (In German).

The stability of the UC_2-phase is of great interest with regard to operating HTR's using dicarbide coated-particle fuel. In the literature the reaction $2\ UC_2 \rightleftharpoons U_2C_3 + C$ is mentioned. There is, however, partial disagreement on the detailed description of the conditions at which U_2C_3 is formed. Experimental results of the reaction of decomposition are presented with special emphasis on the presence of certain moderating or accelerating forces. The enhancement of the decomposition, occurring when additional mechanical energy is brought into the UC_2 matrix, was studied. A maximum in the U_2C_3 forming rate of reaction was observed in the temperature range 1300 to 1400°C. With a material pre-heat treated at 1900°C, however no transformation was detected. U_2C_3 formation is reported after heat treatment of irradiated coated particles, and a stabilization of the dicarbide fuel therefore is advantageous. In this respect the contamination of the UC_2 by N_2, of about 1500 ppM, seems most effective, while oxygen contamination has little or no effect. Of great influence on the reaction is the shape and quantity of the primary graphite precipitation: a large amount of laminar graphite favors the transformation while globular graphite, preferably forming during rapid cooling, inhibits the reaction. (auth)

31425 THERMODYNAMIC DATA FOR SOME NON-STOICHIOMETRIC URANIUM OXIDES BY SOLID-STATE EMF TECHNIQUE. Marchidan, D. I.; Matei, Speranta (Centre of Physical Chemistry, Bucharest). Rev. Roum. Chim.; 17: No. 1-2, 195-202(Jan-Feb 1972).

Electromotive force measurements on high-temperature galvanic cells containing solid electrolyte have been made in order to obtain thermodynamic data for uranium oxides with O/U ratio 2.04, 2.11, 2.19, and 2.21. Partial molar free energies, enthalpies, and entropies of solution of oxygen in these oxides, the corresponding relative integral quantities, as well as the equilibrium pressures of oxygen as a function of the temperature have been calculated. (auth)

31426 CHANGES IN THE STRUCTURE AND PROPERTIES OF TITANIUM CARBIDE WHEN SUBJECTED TO NEUTRON IRRADIATION. Koval'chenko, M. S.; Pogovoi, Yu. I.; Kelim, V. D. At. Energ. (USSR); 32: No. 4, 321-3(Apr 1972). (In Russian).

Changes in the microstructure, lattice parameters, electrical resistance, and microhardness of titanium carbide ($TiC_{0.94}$) at ~50°C, which resulted from exposure to integral doses of thermal neutrons (up to 1.5×10^{20} n/cm^2) were studied. These measurements were taken after such exposure, and again after annealing at temperatures from 100 to 1,000°C for one hr. The samples were prepared from pure, powdered $TiC_{0.94}$ by hot pressing at 2,300°C and 240 kg/cm^2. (K.S.W.)

31427 TRANSMISSION ELECTRON MICROSCOPY OF IRRADIATED BORON CARBIDE. Copeland, G. L.; Dubose, C. K. H.; Donnelly, R. G.; Martin, W. R. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater.; 43: No. 2, 126-32(May 1972).

Boron carbide powders and a section of a high-density pellet were irradiated at 350 to 400°C to a burnup of about 8% of the ^{10}B (16×10^{20} captures/cm^3). The resulting damage was studied by transmission electron microscopy. Techniques of sample preparation are described. A very high density uniform black spot damage was observed. The damage appeared to be similar to that observed in metals due to lattice strain after very high fast fluences. There was no evidence of movement or agglomeration of the reaction products. (auth)

31428 INVESTIGATION OF RADIATION-INDUCED DEFECTS BY THE LOW-TEMPERATURE ELECTRON EMISSION METHOD. Krylova, I. V.; Rakhmatullina, I. A.; Ustinova, T. S. (Moscow State Univ.). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 10, 1437-41(Oct 1971).

Translated from Zh. Fiz. Khim.; 45: No. 10, 2540-5(Oct 1971).

Radioinduced defects in a "decationated" zeolite, magnesium oxide, and zinc oxide and their annealing were investigated by the low-temperature electron emission method. The principal characteristics of the emission, decay kinetics and temperature curves, are independent of the type of ionization (γ radiation and electron bombardment). By irradiating with electron beams, it is possible to simulate the radiation damage caused by the hard penetrating radiation and responsible for electron emission. (auth)

31429 BEHAVIOR OF THE COMPOUND U_3Si UNDER NEUTRON IRRADIATION: MICROSCOPY AND ELECTRON DIFFRACTION. Pelissier, J.; Silvestre, G.; Lombard, L. (CEN, Grenoble, France). J. Nucl. Mater.; 43: No. 2, 93-104(May 1972). (In French).

In-pile irradiation of the U_3Si compound was carried out at different temperatures (200, 300, and 600°C) and to fluences of 10^{15} and 10^{17} fissions/cm^3. The experimental results could best be understood by assuming the occurrence of a simple cubic lattice originating from the tetragonal $\rightleftharpoons$ cubic phase transformation. Actually, the temperature dependence of swelling in the explored irradiation range could be accounted for by the related volume changes. Thereby a new source of dimensional instability was evidenced, lowering still further the chances of U_3Si ever being used as a nuclear fuel. (auth)

31430 CHEMICAL THERMODYNAMIC PROPERTIES OF NUCLEAR MATERIALS. I. URANIUM MONONITRIDE. Oetting, Franklin L. (Dow Chemical Co., Golden, Colo); Leitnaker, James M. J. Chem. Thermodyn.; 4: No. 2, 199-211(Mar 1972).

The high temperature enthalpy $\{H°(T) - H°(298.15°K)\}$ of uranium mononitride was determined from 298 to 1700°K by a copper-block drop calorimeter of the isoperibol type. The experimental results may be expressed by the equation: $\{H°(T) - H°(298.15\ K)\}/cal_{th}\ mole^{-1} = 11.681(T/K) + 1.3291 \times 10^{-3}(T/K)^2 + 9.812 \times 10^4 (K/T) - 3.930 \times 10^3$. The heat capacity of uranium mononitride is expressed as: $C_p^o/cal_{th}\ K^{-1}\ mole^{-1} = 11.681 + 2.6582 \times 10^{-3}(T/K) - 9.812 \times 10^4(K/T)^2$, in the temperature range given above. Combination of these results with the heat capacity and entropy at 298°K available from the literature has made it possible to construct a table of thermodynamic functions for uranium mononitride. An evaluation of the enthalpies of vaporization of uranium mononitride also found in the literature combined with the present enthalpies indicates that the enthalpy of formation at 298.15°K of uranium mononitride is $-(70.6 \pm 1.0)kcal_{th}\ mole^{-1}$ and the enthalpy of vaporization of uranium metal is $(128 \pm 2)\ kcal_{th}\ mole^{-1}$. (auth)

31431 RATE-INDEPENDENT CONTINUUM THEORIES OF GRAPHITE AND THEIR EXPERIMENTAL VERIFICATION. Phillips, A. (Yale Univ., New Haven). Nucl. Eng. Des.; 18: No. 2, 203-11(1972). (CONF-710903-19).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Uniaxial tension-compression tests with artificial graphites have shown that in the temperature range from 75 to 750°F these materials exhibit essentially rate-independent elastoplastic behavior. Consequently, a rate-independent continuum theory of graphite is appropriate for representation of the behavior of these materials within the temperature range indicated. These experiments have also shown that the stress–strain curves are nonlinear even at low stress levels for loading, unloading, and reloading. It follows that a region of purely linear response is either very small or nonexistent even during unloading and reloading. The classical theory of plasticity must therefore be modified to become applicable to the mechanical behavior of artificial graphites. The development of two variations of a continuum theory of artificial graphite is discussed which is based on a generalization of the classical theory of plasticity. Proper experiments to verify them are proposed. (auth)

31432 USE OF MICROSTRUCTURAL DATA FOR VERIFICATION OF FUEL MATERIAL SWELLING MODELS. Merckx, K. R. (WADCO Corp., Richland, Wash.). Nucl. Eng. Des.; 18: No. 1, 41-51(1972). (CONF-710903-12).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Methods for verifying proposed models of reactor fuel material swelling are described using quantitative data obtained from microstructural observations. Because of the range and interaction of the mechanical, thermal, and radiation conditions encountered by reactor fuel elements, microscopic structural observations provide the only source that contains sufficient information to verify fuel swelling models. Various methods for quantitatively interpreting microstructural data are related to their uses for verifying swelling models. Methods for evaluating accumulative properties (volume increase, bubble density count, and specific bubble surface area) in fuel materials having random spatial distributions (describable by a Poisson process) are used to evaluate empirical models. New methods for estimating these properties are described. Size distributions of bubbles are predicted by some models: thus, methods for estimating such size distributions are used to verify these models. A new development for evaluating statistical estimations of size distributional parameters is described. The most detailed and advanced swelling models make predictions on both the size and spatial distributions of swelling bubbles. The combined probabilistic formulation of these models with specialized statistical estimation procedures provides the means for testing the hypotheses used in these models. An application of this technique to a grain boundary dependent swelling model is described. (auth)

31433 THEORETICAL ANALYSIS OF THE STRAINS PRODUCED IN NUCLEAR FUEL CLADDING TUBES BY THE EXPANSION OF CRACKED CYLINDRICAL FUEL PELLETS. Gittus, J. H. (United Kingdom Atomic Energy Authority, Springfields, Eng.). Nucl. Eng. Des.; 18: No. 1, 69-82(1972). (CONF-710903-14).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Some of the stress, force, and strain distributions produced in collapsed cladding by the expansion of cracked pellets during a power increase have been calculated analytically. As the radial and transverse cracks in the pellet open, the tendency for the cladding to stretch preferentially over them is reduced by frictional sliding at the pellet/clad interface. The frictional forces opposing sliding are intensified by a high coolant pressure (which holds the can onto the fuel) while the ability of the cladding to resist the friction forces without being locally deformed depends on its strength. The coefficient of friction, cladding dimensions, number of radial pellet cracks, strain hardenability, and temperature gradients around the cladding influence the tendency for cladding strain to be concentrated over the opening pellet cracks. (auth)

31434 MICROSTRUCTURE OF SOL-GEL-DERIVED $(U,Pu)O_2$ MICROSPHERES AND PELLETS. Lackey, W. J.; Bradley, R. A. (Oak Ridge National Lab., Tenn.). Nucl. Technol.; 14: No. 3, 257-68(Jun 1972).

The microstructure of sintered $(U,Pu)O_2$ microspheres and pellets prepared by the sol-gel process was characterized using light and electron microscopy, electron microprobe analysis, and alpha autoradiography. The material is typically homogeneous in composition, and the grain size is usually between 1 and 5 μm. Coarse microspheres have densities greater than 95% of theoretical, but the fine microspheres approach theoretical density. The microstructure of low-density pellets consists of high-density and medium-density regions in a porous matrix. (auth)

31435 METHOD OF MAKING NUCLEAR FUEL ELEMENTS. Dahlberg, Richard C.; Goeddel, Walter V. (to United States Atomic Energy Commission). U. S. Patent 3,652,744. 28 Mar 1972. Filed 19 Nov 1969.

Nuclear fuel elements which contain different amounts of nuclear fuel in the form of minute particulate nuclear fuel cores having fission product-retentive coatings are made using casings which have the same amount of fuel chamber volume for holding the nuclear fuel. First and second groups of coated fuel particles are used which vary from each other either in core composition, core size, or coating thickness and thereby contain different amounts of nuclear fuel per unit volume of coated particles. Thus, different fuel elements contain different amounts of nuclear fuel as a result of containing different relative amounts of coated nuclear fuel particles from the first and second groups. (Official Gazette)

31436 MATHEMATICAL MODELS FOR CALCULATING THE MECHANICAL BEHAVIOUR OF COATED FUEL PARTICLES. Walther, H. (CRN, Saluggia, Italy). Nucl. Eng. Des.; 18: No. 1, 11-39(1972). (CONF-710903-11).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Coated fuel particles, as used in high-temperature gas-cooled reactors, consist of a fuel kernel and a spherically symmetric multilayer coating. During their lifetime they undergo varying stress states, caused by the simultaneous occurrence of a number of basic physical effects. These effects are discussed on the basis of the presently known data and classified in actions and reactions. The actions, tending to cause deformations, are fuel swelling, fission gas development, irradiation-induced dimensional changes, and thermal expansion; the reactions, tending to restrain the deformations, are elastic and plastic effects, characterized by the buildup of stresses. Model calculation of the stress and deformation state in the system is complicated by delayed elastic and plastic effects, called transient- and steady-state creep, and by the anisotropy and the differential behavior in and between UO_2, pyrocarbon, and SiC. Model development, which is reviewed, is used to describe the total "stress history;" it begins with differential thermal expansion during and after fabrication and continues with fast and thermal neutron-induced dimensional and density changes, fuel swelling, and gas pressure development. It still proceeds when mechanical effects such as decoupling, recoupling, and failure of single layers occur as a consequence of critical states of stress and deformation. It does not end before all layers are broken. The concepts of such a highly developed mathematical model are discussed. They are based on a division of the stress history into single consecutive intervals, each one with small enough deformation and stress variations to allow treatment by the methods of the "classical" linear theory of elasticity. Calculated examples are given, which are used to predict the mentioned physical and mechanical effects. Experience and results of data evaluation show that mathematical model considerations cannot replace test experiments as much as in classical fields. They are important however in designing the experiments and necessary in interpreting them; they provide the only reasonable possibility of extrapolating the results of test irradiations to power reactor conditions. (auth)

31437 ORDERING OF HYDROGEN IN β-VANADIUM HYDRIDE. Wanagel, J.; Sass, S. L.; Batterman, B. W. (Cornell Univ., Ithaca, N. Y.). Phys. Status Solidi (a); 10: No. 1, 49-57(16 Mar 1972).

Electron-microscopic specimens of vanadium, thinned by a technique known to add hydrogen, showed evidence for ordering in β-vanadium hydride. Extra half-order reflections were observed and concluded to be due to scattering from hydrogen. The transformation between the ordered and disordered phases occurs reversibly at a specific temperature in the range 160 to 190°C, depending on the specimen. The reciprocal lattice as determined by electron diffraction was shown to be in the monoclinic Laue group. Indirect evidence places the composition of the ordered phase in the vicinity of V_2H. The possible monoclinic structures consistent with observations place the hydrogens in tetrahedral sites on alternate $(101)_{b.c.t.}$ planes. (auth)

31438 STRUCTURE OF ORTHORHOMBIC $V_{0.95}Cr_{0.05}O_2$. Pierce, J. W.; Goodenough, J. B. (Massachusetts Inst. of Tech., Lexington). Phys. Rev., B; 4104-11(15 May 1972).

A structure determination of the orthorhombic phase of $V_{0.95}Cr_{0.05}O_2$ based on powder data indicates that the probable space group is F222 and the room-temperature lattice parameters are $a_0 = 13.015$ Å, $b_0 = 12.597$ Å, and $c_0 = 5.795$ Å. The structure represents a distortion of the tetragonal rutile structure of high-temperature ($T > 68°C$) V_2O_4 having cell parameters $a_r \approx a_0/2\sqrt{2} \approx b_0/2\sqrt{2}$ and $c_r \approx \frac{1}{2}c_0$. The orthorhombic cell contains $16(V_{0.95}Cr_{0.05})_2O_4$. There are four distinguishable c-axis chains of edge-shared octahedra: Cations V_1 in 4a and V_2 in 4b occupy alternate positions of one chain, the V_1–O separations being nearly uniform (≈1.895 Å), whereas the V_2–O distances along b_0 are shorter (1.85 Å) and the four others are longer (2.04 Å). Cations V_3 in 8j and V_4 in 8i exhibit antiferroelectric displacements along half the c-axis chains, and cations V_5 form V_5–V_5 pairs along the fourth c-axis chain. The relationship of this structure to the semiconductor-to-metal transition in VO_2 is discussed. (auth)

31439 FABRICATION OF SPECIAL MATERIALS BY ISOSTATIC HOT PRESSING. Bauer, F.; Weimar, P. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Werkstofftech.; 1: No. 4, 182-7(1970). (In German).

The process of isostatic hot pressing is described, and the principle of compaction explained. A review of earlier work is given in a literature survey. The plant in Karlsruhe—the first in the ERD—is described. The technique of appropriate sample preparation is shown by two examples. One of these is the compaction of a UO_2–Mo cermet. During isostatic hot pressing a metallurgical bonding between can and fuel was observed. Some applications of the new process are: the fabrication of fuel pins for fast breeder reactors, cathodes and collectors for thermionic emitters, thermal shock-resistant ceramics, and metal-ceramic diffusion bonds. In the field of high-speed steel and hard metals with improved life-time, the new process is advancing. (INIS)

31440 GRAIN GROWTH DURING THE ISOTHERMAL SINTERING OF OXIDE COMPACTS: EFFECT OF POROSITY, COMPOSITION, AND COMPACTION PRESSURES. Das, A. R. (Indian Inst. of Tech., Kanpur). pp 88-103 of Proceedings of the Symposium on Powders and Sintered Products. Bombay; Dept. of Atomic Energy (1971).

From Symposium on powders and sintered products; Kanpur, India (31 Jan 1971). See CONF-710118.

Grain growth during the isothermal sintering of compositions in the ThO_2–CaO system and Fe_2O_3 was studied by optical microscopic methods. In the ThO_2–CaO system the compositions were pure ThO_2 and ThO_2 containing 2.31, 4.25, and 8.8 mole % CaO, the temperatures were 1500, 1550, and 1600°C, and the times varied between 10 to 120 minutes. The additions of CaO caused an increase in sintering rates at the lower temperatures and inhibited grain growth. A coarse grained Fe_2O_3(3 to 5 micron) was sintered at 1250, 1300, and 1350°C for 30 to 240 minutes and grain sizes were noted. For a fine grained Fe_2O_3(~1 micron) the sintering was done at 1006, 1100, and 1200°C for times ranging between 5 to 140 minutes. The initial compaction pressure in the fine material was varied between 720 to 4300 kg/cm^2. Increased pressures enhanced the degree of sintering to some extent but reduced the grain growth rate very significantly. In both systems porosity inhibited grain growth. A semi-emperical derivation is proposed to relate the grain size with the controlling variables of temperature, porosity, and initial compaction pressure, based on the existing models of grain growth and sintering kinetics. This data together with some typical data on BeO and ZnO were examined in relation to the proposed expressions. (auth)

31441 SINTERING STUDIES ON UO_2: CHANGES IN ELECTRICAL CONDUCTIVITY WITH THE PROGRESS OF SINTERING. Rao, S. V. K.; Moorthy, V. K. (Bhabha Atomic Research Centre, Trombay, India). pp 119-40 of Proceedings of the Symposium on Powders and Sintered Products. Bombay; Dept. of Atomic Energy (1971).

From Symposium on powders and sintered products; Kanpur, India (31 Jan 1971). See CONF-710118.

UO_2 powders differing in their mode of origin and calcination temperature differ widely in their sintering behavior. It was observed that the poorer the crystallinity in the resultant UO_2 powders the greater was their sinterability. The sintering of UO_2 powder compacts brings about changes in crystallinity, density, and microstructure. It was considered that such changes during the progress of sintering would be reflected in changes of electric conductivity of the UO_2 pellets. Specimens of UO_2 pellets were made by cold-pressing powders of different crystallinity prepared from ADU by calcination/reduction at temperatures from 600 to 1500°C and sintered at temperatures of 600 to 1500°C. Samples from some of the powders were sintered at temperatures up to 1700°C. Electric conductivities of all the specimens were measured at room temperature. Attempts were made to explain the changes in conductivity on the basis of crystallinity development in the powders, densification of the compacts, and changes in microstructure. (auth)

31442 DEVELOPMENT OF MORPHOLOGY AND CRYSTALLINITY IN MAGNESIA AND BERYLLIA POWDERS. Moorthy, V. K.; Pathak, C. M.; Prasad, G. Eswara; Rao, S. V. K. (Bhabha Atomic Research Centre, Trombay, India). pp 141-63 of Proceedings of the Symposium on Powders and Sintered Products. Bombay; Dept. of Atomic Energy (1971).

From Symposium on powders and sintered products; Kanpur, India (31 Jan 1971). See CONF-710118.

It has been established that the sinterability of pure oxide powders depends to a large extent on the physical characteristics of the powder particles. The effects of origin and calcination treatments on the morphology, crystallinity, and specific surface area of the resultant magnesia and beryllia powders were studied.

Attempts were made to relate the changes in these properties and the sintering behavior of the powders. (auth)

31443 PREPARATION OF SINGLE PHASE URANIUM MONOCARBIDE OF CONTROLLED MICROSTRUCTURES BY REACTION SINTERING. Zope, B. D.; Moorthy, V. K. (Bhabha Atomic Research Centre, Trombay, India). pp 164-77 of Proceedings of the Symposium on Powders and Sintered Products. Bombay; Dept. of Atomic Energy (1971).

From Symposium on powders and sintered products; Kanpur, India (31 Jan 1971). See CONF-710118.

The fabrication of high-density single-phase uranium monocarbide pellets at low temperatures was found to be possible by reaction sintering. For this, a stoichiometric mixture of uranium dicarbide and uranium metal powder was first warm-pressed at 800°C to a density around the theoretical density of the monocarbide. The warm-pressed compacts were then reaction sintered at the desired temperature, to complete the conversion to monocarbide and attain the desired microstructure. (auth)

31444 FABRICATION ASPECTS IN POWDER METALLURGY OF FUEL MANUFACTURE. Kantan, S. K.; Sinha, K. K. (Bhabha Atomic Research Centre, Trombay, India). pp 178-90 of Proceedings of the Symposium on Powders and Sintered Products. Bombay; Dept. of Atomic Energy (1971).

From Symposium on powders and sintered products; Kanpur, India (31 Jan 1971). See CONF-710118.

Large-scale production methods as applied to fuel fabrication by powder metallurgy are described, and the problem areas from the view point of higher production and cost reduction are identified. The importance of statistical quality control over mass production is highlighted. Also, a brief description of a large-scale production facility is given. (P.C.H.)

31445 PYROCHLORE TYPE STRUCTURES IN URANIA–RARE EARTH OXIDE SYSTEMS. Awasthi, S. K.; Chawla, K. L.; Chackraburtty, D. M. (Bhabha Atomic Research Centre, Trombay, India). pp 261-8 of Proceedings of the Symposium on Powders and Sintered Products. Bombay; Dept. of Atomic Energy (1971).

From Symposium on powders and sintered products; Kanpur, India (31 Jan 1971). See CONF-710118.

The pyrochlore-type structures $A_2^{3+}B_2^{4+}O_7$, where A is the rare earth and B is uranium, were studied in the system UO_2–$REO_{1.5}$. When A is La or Nd, the pyrochlore phase was observed whereas other rare earths down the lanthanide series showed only a distorted fluorite structure. Essential features of pyrochlore structure are discussed and x-ray diffraction data for $La_2U_2O_7$ and $Nd_2U_2O_7$ are presented. (auth)

31446 X-RAY STUDY OF SOLID-SOLUTION FORMATION IN URANIA–THORIA POWDER COMPACTS. Krishnan, R.; Mohan, Ashok; Kumar, Lalit (Bhabha Atomic Research Centre, Trombay, India). pp 269-76 of Proceedings of the Symposium on Powders and Sintered Products. Bombay; Dept. of Atomic Energy (1971).

From Symposium on powders and sintered products; Kanpur, India (31 Jan 1971). See CONF-710118.

The urania–thoria phase diagram exhibits a continuous solid solubility throughout the entire composition range both in the solid and liquid states. The process of solid solution formation in a 50–50 UO_2–ThO_2 mixture was studied by x-ray line broadening investigations over the temperature range 1200 to 1500°C. It was found that the activation processes for solid solution formation were different in different temperature zones. An activation energy of 76 kcal/mole for interdiffusion was associated with the temperature range of 1200 to 1350°C, while above 1350°C, the process corresponds to an activation energy of 107 kcal/mole. (auth)

Metals and Alloys

Refer also to abstracts 30931, 31202, and 31399.

31447 ELECTRON MICROSCOPY IN MATERIAL SCIENCE. Ettore Majorana International Centre for Scientific Culture 1970 International School of Electron Microscopy, A NATO Advanced Study Institute, Erice, Italy, April 4–18, 1970. Valdre, U. (ed.). New York; Academic Press, Inc. (1971). 774p. $35.00. (CONF-700454).

Separate abstracts were prepared for 3 of the 19 papers presented. The remaining 16 papers were not in scope of NSA. (W.H.K.)

31448 IMPACT OF TRANSMISSION ELECTRON MICROSCOPY IN THE SCIENCE OF MATERIALS. Hirsch, P. B. (Oxford Univ.). pp 2-11 of Electron Microscopy in Material Science. /Valdre, U. (ed.). New York; Academic Press, Inc. (1971).

From International school of electron microscopy; Erice, Italy (4 Apr 1970).

The fields in which transmission electron microscopy has made special impact include studies on dislocation theory, mechanical properties, point defects and dislocations, radiation damage, phase transformations, kinetic studies, surface layer studies, and magnetic properties. (19 references) (M.C.G.)

Corrosion and Erosion

31449 (AAEC/TM-601) CORROSION RESISTANCE OF SOME ALPHA-DISPERSOID ZIRCONIUM ALLOYS IN WATER VAPOUR AT 400°C AND 500°C. Clare, T. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Sep 1971. 34p. Dep. NTIS (U. S. Sales Only).

The corrosion of Zr, Zircaloy-4, Zr–2.5 Nb, Zr–1.15 Cr–0.1 Fe, and experimental binary alloys of Zr with Cu, Ni, Fe and Cr was studied at 400 and 500°C in moist helium. The volume fraction of the second phase in the experimental alloys was approximately constant but the distribution and size of the second phase varied slightly from alloy to alloy. Nevertheless, the corrosion behavior of the alloys was correlated with composition and solute distribution after corrosion, assuming similar metallurgical structures. No alloying addition significantly improves the corrosion resistance of pure Zr at 400°C though Ni and Cu improve it at 500°C. The order of increasing corrosion resistance prior to transition appears to follow the order of decreasing alloy solubility in the oxide film. The time to transition and corrosion rate after transistion are also related to alloy solubility in the oxide film. Zircaloy-4, Zr–2.5 Nb and Zr–Cr alloys may not be suitable for service in moist atmospheres at 400 to 500°C, whereas Zr–Cu, Zr–Fe and Zr–Ni alloys show superior corrosion resistance under these conditions. (auth)

31450 (LMEC-72-1) LIQUID METAL ENGINEERING CENTER (LMEC). Annual Technical Progress Report, January–December 1971. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). 24 Mar 1972. Contract AT(04-3)-700. 282p. Dep. NTIS.

Progress is reported on FFTF and LMFBR testing devoted to steam generators, pump seals, valve freeze seals, insulation, precision mechanisms, materials compatibility, creep, instrumentation, piping stress, thermal shock, and strain gages. Activities directed to maintenance of LMEC facilities are reviewed. (J.R.D.)

31451 (N-72-14548) OXIDATION/VAPORIZATION OF SILICIDE-COATED NIOBIUM-BASE ALLOYS. Kohl, Fred J.; Stearns, Carl A. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec 1971. 52p. (NASA-TM-X-67980; E-6704). NTIS.

Mass spectrometric and target collection experiments were made at 1600°K to elucidate the mode of oxidative vaporization of two niobium alloys, fused-slurry-coated with a complex silicide former (Si–20Cr–Fe). At oxygen pressures up to 0.0005 torr the major vapor component detected by mass spectrometry for oxidized samples was gaseous silicon monoxide. Analysis of condensates collected at oxygen pressures of 0.1, 1.0, and 10 torr revealed that chromium-, silicon-, iron-, and tungsten-containing species were the major products of vaporization. Equilibrium thermochemical diagrams were constructed for the metal-oxygen system corresponding to each constituent metal in both the coating and base alloy. The major vaporizing species are expected to be the gaseous oxides of chromium, silicon, iron, and tungsten. Plots of vapor phase composition and maximum vaporization rate versus oxygen pressure were calculated for each coating constituent. The major contribution to weight loss by vaporization at oxygen pressures above 1 torr was found to be the chromium-containing species. (auth) (STAR)

31452 (RD/B/N-2215) OXIDATION OF NIMONIC 80A AT 800°C IN LOW OXYGEN PRESSURES. Wild, R. K. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb 1972. 24p. (RPC/CM/P-(72)23). Dep. NTIS (U. S. Sales Only).

The oxidation of samples of Nimonic 80A which were exposed at 800°C to low oxygen pressures in an ultrahigh vacuum system is described. The surface composition during oxidation was monitored by Auger electron spectroscopy. After oxidation was complete the surface structure was examined using transmission and scanning electron microscopy, and the oxide composition determined by microprobe analysis. A comparison was made between Nimonic 80A oxidised in low oxygen pressures and Nimonic 80A exposed at 850°C in a helium atmosphere of 1.8×10^{-5} Nm^{-2} pressure. The relevance of exposure of samples to low partial pressures of corrosive gases to corrosion in helium environments is discussed. (auth)

31453 (RFP-1824) STRESS-CORROSION CRACKING BEHAVIOR OF THE U-4.2 WT % Nb ALLOY AGED 80 HOURS AT 260°C. Macki, James M.; Kochen, Robert L. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 20 Mar 1972. Contract AT(29-1)-1106. 12p. Dep. NTIS.

The stress-corrosion cracking (SCC) behavior of the U-4.2 wt % Nb alloy aged 80 hours at 260°C was investigated. Smooth four-point bend SCC tests and smooth static tensile SCC tests were used. The results of this study show that the aged U-4.2 wt % Nb alloy is susceptible to SCC when stressed and exposed to water containing oxygen and chloride ions. The SC cracks which nucleate in the aqueous chloride environments proceed by an intergranular SCC fracture mode. No failures were observed in dry air containing less than 200 ppM moisture or in 100% relative humidity air. The surface tensile stress required for SCC is less than 20,000 psi in oxygen-saturated water containing 50 ppM chloride ions. (auth)

31454 (STU-70-394/U-325) ELECTROCHEMICAL METHODS FOR CONTINUOUS MEASUREMENT OF CORROSION RATES ESPECIALLY WITH HIGH TEMPERATURE EQUIPMENT MADE OF CARBON STEEL, STAINLESS STEEL 18/8, AND ZIRCALOY-2. Tarkpea, P.; Johansson, B.; Huebner, W.; Lundberg, K. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Oct 1971. 69p. (In Swedish). (AE-MK-271). Dep. NTIS (U. S. Sales Only).

An examination is described with the aim of developing a measuring method for continuous measurement of corrosion rates during operation at high temperature. The measurements are based on determination of the potential (polarization) as a function of an applied current in a range near the corrosion potential. A linear function is adequate, and the derivative $d\eta/dI$, polarization resistance is reciprocally proportional to the rate of corrosion (corrosion current). In the proportional constants, the so-called Tafel constants are included, i.e., the derivatives in the ranges of strong anodic or cathodic polarization, where the counteracting process can be neglected and a logarithmic function is adequate (Tafel curves). The polarization resistance has been measured and the Tafel constants have been determined for carbon steel, stainless steel 18/8 in de-ionized water with high, about 2 ppM, and low, about 0.5 ppM, O_2 at 250°C, and for Zircaloy-2 in equivalent water at 300°C. This environment is of interest in nuclear reactor operation. The polarization resistance has been determined with both charging curve analysis and transient linear polarization. The corrosion rates have been calculated. Comparisons have been done with gravimetric determinations of the corrosion and determinations of corrosion current through extrapolation of the cathodic Tafel curves. The results showed that the corrosion rate is 38 mdd for carbon steel, 1 mdd for stainless steel and 1 mdd for Zircaloy-2. The corrosion rates determined by the different methods agreed well with each other. (Sweden)

31455 DISCUSSION OF OXIDATION PROPERTIES OF WC 3015. Elkington, W. E.; McDonald, W. K. (Teledyne Wah Chang Albany Corp., Oreg.). Met. Trans.; 3: No. 4, 1007-9 (Apr 1972).

Findings on oxidation of Nb alloys Cb 752 and WC 3015 are compared with those of A. A. Tavassoli [Met. Trans., 2: 1985-6(1971)]. Tavassoli has concluded that "WC 3015 oxidizes faster than Cb 752" for periods less than 40 minutes. Contrary to this conclusion, air oxidation tests were performed which show that after a 5 min exposure at 2400°F, Cb 752 is completely oxygen-contaminated whereas oxygen has penetrated only about half way into the 20 mil sheet sample of WC 3015. Tavassoli, in reply, notes that a major difference between his conclusions and those of Elkington and McDonald results from the use of the terms oxide and oxygen. It should be noted that the term "oxide" defines the compound of oxygen with an element(s). However, during an oxidation test free oxygen may penetrate beyond the oxide-substrate interface forming solid solutions. Tavassoli presents evidence that the oxide penetration data in his study are valid. (J.R.D.)

31456 EFFECT OF HEAT TRANSFER ON ZIRCALOY CORROSION IN HIGH-TEMPERATURE WATER. Mrkous, P. Jad. Energ.; 18: No. 3, 91-6(1972). (In Czech).

The corrosion rate of Zircaloy-type alloys in pure water was found to be higher under heat-transfer conditions than under isothermal conditions. The oxidation rate was determined chiefly at the hot surface of the heat exchanger. Oxidation of Zircaloy-type alloys was more rapid under boiling conditions than in a medium without boiling at the same temperature. At a surface undergoing oxidation with associated changes in the oxidation rate the temperature probably rises, and fluctuations occur in the boiling stream. Absorption of hydrogen during corrosion in water was higher under heat-transfer conditions than under isothermal conditions and was probably a result of the high temperature of the wall. There was no difference in the hydrogen absorption rate under boiling conditions and under heat-transfer conditions without a boiling medium. In water containing lithium hydroxide (pH 10) with heat transfer and boiling, there was serious danger of corrosive attack, chiefly at the joints. (TTT)

31457 LOW-TEMPERATURE OXIDATION OF U-Nb AND U-Nb-Zr ALLOYS. Cathcart, J. V.; Petersen, G. F. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater.; 43: No. 2, 86-92(May 1972).

The rates of oxidation of U-9.4 wt % Nb and U-7.5 wt % Nb-2.5 wt % Zr were measured between 100 and 300°C in purified oxygen. An activation energy of approximately 13 kcal/mole was obtained for both alloys. The effects of H_2O, SO_2, and CCl_4 on the oxidation rate of the ternary alloy were small. Metallographic studies revealed the oxide films to be compact and uniform, although significant oxidation rate anisotropy was observed during the early stages of oxidation. (auth)

31458 WELDABILITY AND CORROSION RESISTANCE OF A Ti-5 PERCENT Ta ALLOY. Blashchuk, B. E.; Gurevich, S. M.; Zotova, L. M.; (and others). Avtomat. Svarka; No. 6, 16-19 (Jun 1971). (In Russian).

The alloy Ti-5% Ta is suggested for working with HCl in the presence of an oxidizer at elevated temperatures. Production of this alloy by industry has begun under the assigned identification "·;204". The Ti alloy possesses satisfactory welding properties, and welds offer good resistance to corrosion in the stressed state in 18% HCl at 90°C in the presence of gaseous Cl_2. The welded joints tend toward inter-crystallite fracture. (tr-auth)

31459 CORROSION INHIBITORS. Proceedings of the 3rd European Symposium, Ferrara, Italy, September 14-17, 1970. Ferrara, Italy; Universita Degli Studi di Ferrara (1971). 945p. (In several languages). (CONF-700978).

Fifty-nine articles are included; a separate abstract was prepared for each of two. The remaining 57 articles contain information on: electrode reactions; inhibition in pickling; inhibition in the petroleum industry; inhibition in cooling water systems; corrosion inhibitors for various alloys and metals; absorption mechanism of organic corrosion inhibitors; relation between effectiveness of corrosion inhibitors and their chemical structure; radiochemical measurements on inhibition phenomena; role of oxygen on dissolution of Fe in water; thermodynamic kinetics of Fe as a mixed polyelectrode in the presence of chromates; characterization, corrosion, and inhibition of ancient etruscan bronzes. (P.C.H.)

For abstracts of individual papers see: 31460 and 31461.

31460 KINETICS OF INHIBITORS' TRANSFORMATION DURING THE CORROSION PROCESS IN ACID MEDIA. Poutilova, I. N. (Moscow Food Industry Inst.). pp 499-500 of Corrosion Inhibitors. Ferrara, Italy; Univ. Degli Studi di Ferrara (1971).

From third European symposium on corrosion inhibitors; Ferrara, Italy (14 Sep 1970). See CONF-700978.

Studies were made on chemical transformations of corrosion inhibitors with iron, molybdenum, and nickel in acids. Non-oxidizing acids HCl, H_2SO_4, citric and oxidizing HNO_3 were used. It was found, that organic and inorganic inhibitors were changing during the first minutes of the corrosion process. The changing of inhibitors' concentration during the corrosion process was carefully measured. Short time inhibitors were changing and kinetics of these reactions were of the zero or the first order. It is suggested that the reaction of the zero order of inhibitors' transformations would be the reaction on the metals' surface. In experiments with HNO_3, it was found that inhibitors in this acid were mostly deactivators of dissolution process. (auth)

31461 INHIBITION OF CORROSION OF CARBON STEEL IN NUCLEAR INSTALLATION CIRCUITS. Coriou, H.; Grall, L.; Willermoz, H. (CEN, Fontenay-aux-Roses, France). pp 627-42 of Corrosion Inhibitors. Ferrara, Italy; Univ. Degli Studi di Ferrara (1971). (In French).

From third European symposium on corrosion inhibitors; Ferrara, Italy (14 Sep 1970). See CONF-700978.

The use of carbon steel in nuclear construction leads to the necessity of defining corrosion inhibitors resistant to radiation or presenting simultaneously properties of a neutron poison. Therefore, two types of solution have been perfected. The first is based on the use of trisodium phosphate (0.5 g/l) treated with soda (pH 12). It was found that the inhibiting qualities of this solution are very good and are maintained for high doses of gamma and neutron radiation. The second, consisting of borax, makes it possible to obtain an excellent behavior of the steel meanwhile assuring effective protection against nuclear criticality. Industrial utilization has confirmed the results of the studies. (tr-auth)

31462 CORROSION PREVENTION FOR PIPING IN NUCLEAR POWER PLANTS IN JAPAN. Imoto, Yasuo (Nippon Corrosion Engineering Co. Ltd., Tokyo). Haikan Gijutsu; 13: No. 10, 81-92(Oct 1971). (In Japanese).

In the construction of nuclear power plants in Japan, cooling water is obtainable from the sea. Nuclear power plant piping requires proper corrosion prevention measures corresponding to establishing conditions for the prevention of leakage and long term use. Corrosion is an ionizing reaction of metal caused by electrochemical mechanisms when the electrolyte, such as soil or water, is in contact with the surface of the metal. Factors affecting the corrosion are composition, residual stress, temperature, sticking substances such as mill scale, and lack of uniformity in surface treatment of the metal, and the composition, salt concentration, amount of dissolved oxygen, and pH of the electrolyte. The effects of the major factors are explained. Surveys on corrosive environments should be carried out at plant sites when the corrosion prevention measures are planned, and usually measurements of resistivity and pH of soil and potential difference between piping and earth are carried out. Corrosion prevention is accomplished by painting, lining, and cathode protection methods. Piping buried in earth must be coated with high electric resistance material, and the cathode protection must be applied simultaneously. There are current-producing anode-type and external source-type in the cathode protection method. Examples of the execution of the cathode protection method for the piping in nuclear power stations are given. (Japan)

Preparation and Fabrication

Refer also to abstracts 31038, 31041, 31393, 32284, 32687, and 32688.

31463 (FRNC-CONF-25) WELDING OF THICK AUSTENITIC STAINLESS STEELS BY ELECTRON BOMBARDMENT. Bocquet, M. (Societe Creusot-Loire, Paris (France)). 1971. 20p. (In French). (CONF-711043-1). Dep. NTIS (U. S. Sales Only).

From Meeting on special steels; Paris, France (28 Oct 1971).

Austenitic stainless steels in the bulk state or in the form of platings are used in reactors. Electron beam welding appears to be the most suitable technique for such constructions from the point of view of the identity of the chemical composition between the joint and the base metal, the high cooling rate obtained, and the subsequent relatively small deformation involved. Tests were performed on three slightly different austenitic stainless steels. The welding conditions and the results of metallurgical studies carried out are presented: chemical composition, micro and macro characteristics of tensile tests, creep, ductility, and intergranular corrosion tests. The method was compared with arc welding. (France)

31464 (RDT-M-2-5-T(4-72)) AUSTENITIC STAINLESS STEEL WELDING FITTINGS (ASME SA-403 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Apr 1972. 12p. RSO.

A standard prescribing requirements for austenitic stainless steel welding fittings (ASME SA-403 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 2-5 T, dated July 1971. (J.R.D.)

31465 (Y-SC-39) MACHINING DEPLETED URANIUM. Hurst, J. S.; Read, A. M. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 24 Apr 1972. Contract W-7405-eng-26. 15p. Dep. NTIS.

The experience gained by the Oak Ridge Y-12 Plant in machining and handling depleted uranium is summarized. Parameters are given for turning, boring and facing, cutting, drilling, gun drilling, reaming, threading, tapping, milling, and grinding. Health and safety hazards involved in the machining of depleted uranium are also discussed. (auth)

31466 ADVANCED EXPERIMENTAL TECHNIQUES IN POWDER METALLURGY. Symposium Held at the Spring Meeting of the Metallurgical Society of AIME in Pittsburgh, Pennsylvania, May 12-15, 1969. Hirschhorn, Joel S.; Roll, Kempton H. (eds.). Perspectives in Powder Metallurgy. Fundamentals, Methods, and Applications. Volume 5. New York; Plenum Publishing Corporation (1970). 260p. $15.00. (CONF-690567).

Nine chapters are included in the book. A separate abstract was prepared for each of two chapters selected for inclusion in NSA. Chapters for which no abstracts were prepared are concerned with electron microscopy, properties of sintered powdered metals, and Hg porosimetry. (J.R.D.)

For abstracts of individual chapters see: 31468 and 31469.

31467 MELTING, CASTING, AND SHAPING LEAD SHIELDING BLOCKS: METHOD AND TOXICITY ASPECTS. Karzmark, C J.; Huisman, P. A. (Stanford Univ., Calif.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 114: No. 3, 636-8(Mar 1972).

The procedures for melting, casting, and shaping lead for use in anatomical shielding are described. The associated toxicity hazards are briefly reviewed. (J.R.D.)

31468 BUBBLE RAFT MODEL TO STUDY SINTERING BY PLASTIC FLOW. Lenel, F. V.; Ansell, G. S.; Morris, R. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Perspect. Powder Met.; 5: 61-80(1970).

From Symposium on advanced experimental techniques in powder metallurgy; Pittsburgh, Pa. (12 May 1969).

Films of the sintering of bubble rafts show that the observed sintering process, from neck growth to pore closure, can occur entirely by elastic deformation and dislocation shear processes. An important step in the observed reactions seems to be dislocation nucleation at the sharp corners marking the edges of the necks. It is suggested that the initial sintering of soft metals may occur by processes similar to those observed in the bubble rafts since the inter-bubble forces have been shown to closely resemble those in a metal lattice, and the multiplicity of slip systems in the metal lattices is clearly sufficient to accomplish the required changes in shape. (auth)

31469 TECHNIQUES FOR THE STUDY OF HOMOGENIZATION IN COMPACTS OF BLENDED POWDERS. Heckel, R. W.; Lanam, R. D.; Tanzilli, R. A. (Drexel Univ., Philadelphia). Perspect. Powder Met.; 5: 139-88(1970).

From Symposium on advanced experimental techniques in powder metallurgy; Pittsburgh, Pa. (12 May 1969).

The experimental techniques of x-ray compositional line broadening, electron microprobe analysis, quantitative metallography, and mathematical models developed from numerical methods and computer techniques are complementary approaches to the study of powder compact homogenization. The experimental techniques described provide a direct, quantitative measurement of structural changes occurring during homogenization. Mathematical models of homogenization are presented which are in general agreement with experimental data and serve to provide predictions of the effects of processing variables. Caution should be exercised, however, in using a mathematical model in an untried system or under conditions where the compact geometry departs appreciably from the ideal geometry used to formulate the model. (auth)

31470 Cu-Zr AND Cu-Zr-Cr ALLOYS PRODUCED FROM RAPIDLY QUENCHED POWDERS. Sarin, V. K.; Grant, N. J. (Massachusetts Inst. of Tech., Cambridge). Met. Trans.; 3: No. 4, 875-8(Apr 1972).

The production of alloys by means of ingot technology leads to micro- and macrosegregation, separation of phases and impurities, often into large, brittle particles, and coarse grain size. Alloy development is frequently restricted because of the coarseness of the structure and the resultant imposed limitations on hot and cold plasticity. One ready means of avoiding these problems is to produce the alloy in powder or pellet form; this permits attainment of high cooling rates in the liquid and solid, minimizes segregation, alters phase separation and distribution advantageously, and results in significantly finer structures. The powders utilized to produce wrought shapes may be much coarser than press-and-sinter powders, leading to important processing economies without sacrifice of structure refinement. The alloy systems Cu-Zr and Cu-Zr-Cr were selected for the study; these are high conductivity, high strength alloys of commercial interest. Cooling rates for these specific powders using nitrogen atomization varied from about 10^3 to 10^4 °C/s. Powders were cleaned, canned, and hot extruded to produce bar stock; mechanical testing was performed on both as-extruded and thermomechanically-worked samples, with highly beneficial improvements in strength, ductility, and high-temperature structural stability. (auth)

31471 RHENIUM VOLATILIZATION DURING MOLYBDENITE ROASTING. Ammann, P. R.; Loose, T. A. (Kennecott Copper Corp., Lexington, Mass.). Met. Trans.; 3: No. 4, 1020-2(Apr 1972).

Results of a study on the oxidative evaporation of Re from natural molybdenite concentrates under controlled conditions are presented. Results confirmed the general relations between Re vaporization and molybdenite oxidation. Higher rates were observed in the experiments than were previously reported. These higher rates were the result of intimate gas–solid contact. It appears that Re oxidizes and vaporizes at lower stages in the process and is reduced and condensed at higher stages. (J.R.D.)

31472 NUCLEATION AND GROWTH CHARACTERISTICS OF PALLADIUM AND INDIUM THIN FILMS. **Singh, H. P.; Murr, L. E. (Univ. of Southern California, Los Angeles). Contract AT(04-3)-113. Met. Trans.; 3: No. 4, 983-8(Apr 1972).**

Observations on the nucleation and growth of palladium and indium thin films deposited onto heated (001)-sodium chloride substrates are reported. It has been observed that the nucleation and growth characteristics of palladium and indium are different. The differences have been explained on the basis of classical nucleation theory. Studies on the effect of lateral electric fields on the epitaxial growth of these films have also been made. No predominant effects were observed with flash evaporation. This may be due to either the absence of positive charges in the vapor stream; or the enhancement of coalescence due to the ineffectiveness of the electric field in the presence of high supersaturation. (auth)

31473 DEOXIDATION OF TANTALUM WITH LIQUID CALCIUM. **Swisher, J. H. (Sandia Labs., Livermore, Calif.); Fuchs, E. O.; Baldwin, W. M. J. Metals; 23: No. 5, 34-6(May 1971).**

A study has been made of the feasibility of deoxidizing solid tantalum with liquid calcium. The rate of deoxidation of 0.5 cm diameter tantalum rods was measured. As an example, the oxygen content was reduced from 1765 to 100 ppM in 22 h at 1000°C. The probable rate controlling step is the diffusion of oxygen in tantalum. In extending the study to the deoxidation of sintered and anodized tantalum powder, it was found that the oxygen content could be reduced from 6600 to approximately 300 ppM in a few hours at 1000°C. Capacitors were made from powders deoxidized in calcium without difficulty. The results of electrical property tests on these capacitors are very encouraging. (auth)

31474 EXOTHERMIC FUSION OF EASTERN TIN SLAG CARBIDES TO A TANTALUM–COLUMBIUM CONCENTRATE. **Gustison, R. A.; Cenerazzo, J. A. (Kawecki Berylco Industries, Inc., Boyertown, Pa.). J. Metals; 23: No. 8, 45-8(Aug 1971).**

A process is described for beneficiating the tantalum and niobium contents of an iron-bearing tin slag, or other metallurgical by-product, by smelting the slag with carbon to convert the tantalum and niobium oxides to a hearth product containing the tantalum and niobium as carbides in admixture with a carbon-containing iron alloy, separating oxidic gangue constituents from the hearth product, reacting the hearth product with sodium nitrate to oxidize all metallic constituents, and leaching the resulting fusion mass with water and mineral acid. When starting with an Eastern tin slag containing about 8% $(TaNb)_2O_5$ the beneficiated product contained 40 to 50% $(TaNb)_2O_5$. (auth)

31475 MOLYBDENUM METAL BY THE BOMB REDUCTION OF MoO_3. **Schmidt, F. A.; Bergman, R. M.; Carlson, O. N.; Wilhelm, H. A. (Ames Lab., Iowa). J. Metals; 23: No. 8, 38-44(Aug 1971).**

A process has been developed for the preparation of high-purity molybdenum metal; the metal is recovered as an alloy by a metallothermic reduction of MoO_3 in a bomb-type chamber. Aluminum, silicon, and mixtures of aluminum and silicon were investigated as reductants for MoO_3. Molybdenum metal yields of 85 to 93% were consistently obtained in the reduction step. Subsequent removal of the excess reducing agent and of some impurities was accomplished by heating in vacuum. The as-reduced metal was converted into sponge by induction heating, or into ingots by direct electron-beam melting. The resulting metal is of 99.98% purity. The hardness-temperature relationship for this material in the range of 25 to 400°C was also determined. (auth)

31476 ELECTROCHEMICAL GRINDING OF CYLINDRICAL TEST SPECIMENS. **Knight, T. W. (Pratt and Whitney Aircraft, Middletown, Conn.); Barrow, R. B.; Williams III, L. W.; Wells, C. H. J. Eng. Ind.; 93: No. 4, 1090-2(Nov 1971).**

The application of electrochemical grinding to the production of complex cylindrical test specimens of novel high-temperature materials is described. Design features and the performance of an ECM cylindrical grinding machine are presented. The process reduced the grinding time per specimen from several hours to a few minutes and resulted in comparable or superior surface finish and dimensional tolerances, as well as a marked reduction in wheel wear. (auth)

31477 ANALYTICAL INVESTIGATIONS OF COMPACT REINFORCEMENT FOR RADIAL NOZZLES IN SPHERICAL SHELLS. **Gwaltney, R. C.; Corum, J. M. (Oak Ridge National Lab., Tenn.). J. Eng. Ind.; 93: No. 4, 905-12(Nov 1971).**

Compact reinforcement for a series of models having single nozzles radially attached to spherical shells was examined by means of finite element analyses. Parameters studied were diameter-to-thickness ratios of the nozzles, diameter-to-thickness ratios of the spherical shells, percentage of reinforcement, outside reinforcement, inside reinforcement, and "balanced" (reinforcement on both the inside and outside surfaces). The loading was internal pressure. Comparisons of theoretical predictions with experimental results are presented for one reinforced model. Twelve models were analyzed to examine the effect of compact reinforcement. (auth)

31478 PURIFICATION OF REACTIVE METALS. **Henrie, Thomas A. (to Secretary of the Interior). U. S. Patent 3,650,931. 21 Mar 1972. Filed 5 Jun 1969.**

A method is described for the purification of reactive metals, such as rare-earth metals, by electrotransport in a pulsed direct current electric field. (Official Gazette)

31479 AUGER ELECTRON SPECTROSCOPY STUDIES OF SPUTTER DEPOSITION AND SPUTTER REMOVAL OF Mo FROM VARIOUS METAL SURFACES. **Tarng, M. L.; Wehner, G. K. (Univ. of Minnesota, Minneapolis). J. Appl. Phys.; 43: No. 5, 2268-72(May 1972).**

Copper, Au, Al, and W samples were mounted in an ultrahigh vacuum (UHV) chamber such that in situ Ar ion sputter cleaning as well as sputter deposition and sputter removal of Mo and Auger analysis could be performed. The Auger signals indicated that Mo on W forms uniform films while on Cu, Au, and Al the deposited Mo atoms agglomerate into multilayer islands. The sputter removal of the deposited Mo from W proceeds as if Mo is sputtered from Mo. On Cu, Au, and Al, the Ar ion bombardment causes spreading of the Mo more uniformly over the surface. The sputtering yield of Mo atoms from Cu, Au, and Al, especially at low energies, is much lower than that of Mo from Mo. Two hundred-eV Ar^+ ions remove Mo atoms from an Al surface with a yield which is more than three orders of magnitude lower than the bulk Mo yield. Thus, a significant conclusion is that the use of low-energy ion bombardment (under normal incidence) for layer removal in determination of depth-composition profiles may often lead to erroneous results. (auth)

31480 SINTERING OF COBALT–RARE EARTH PERMANENT MAGNETS. **Benz, M. G.; Martin, D. L. (General Electric Co., Schenectady, N. Y.). pp 1082-6 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).**

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The process sequence used to fabricate high-performance cobalt–rare earth permanent magnets is a powder metallurgy-type of process with sintering as a key step. Precise control of the composition of the sintered magnet is essential if high magnetic performance is to be achieved. In this study results from two approaches are compared: (1) direct control of composition at the melting stage, and (2) control of composition by blending together powders of different compositions at a stage prior to alignment and densification. (auth)

31481 UNTEMPERED ULTRA-HIGH STRENGTH STEELS OF HIGH FRACTURE TOUGHNESS. **Zackay, V. F.; Parker, E. R.; Goolsby, R. D.; Wood, W. E. (Univ. of California, Berkeley). Nature (London) Phys. Sci.; 236: No. 68, 108-9(17 Apr 1972).**

Factors contributing to notch brittleness in high-strength steels are being studied and it has been learned how to increase the fracture toughness of steels having yield strength in excess of 200,000 lb/sq in. by as much as 70%. The treatments employed differ significantly from normal commercial practice for quenched and tempered low-alloy steels. It was concluded that in order to achieve high fracture toughness it is neither necessary nor desirable to quench directly from a high austenising temperature. A two-stage quench minimises the danger of quench cracking and results in about the same fracture toughness as a single quench from the highest austenising temperature. Also, it appears that for the more highly alloyed steels the austenising temperature is more important than quenching rate for optimising toughness. Again, for the low austenising temperature employed in commercial practice (870°C) the fracture toughness is only about half that attainable by the two-step austenising treatment. It was also found that quenching in media other than oil results in quench cracking to a much greater extent under single austenising at 870° than when the two-step treatment is used. The studies suggest that certain isothermal decomposition reactions can occur leading to products that reduce toughness. Mixed microstructures are known to be deleterious to toughness, especially when a minor phase is present as a network in the original austenite grain boundaries. The effectiveness of a high austenising temperature in reducing brittleness is attributed to the fact that grain boundary nucleation of a second phase is retarded when the high energy grain boundaries associated with small grains are eliminated by grain growth. (The studies were made under the auspices of the USAEC.) (UK)

31482 POWDER FLAME SPRAYING USING THE FONTAREN PROCESS. Wuich, W. Metall-Reinig. Vorbehandl.; 18: No. 11, 484-6(1970).

The use of the flame spraying method for application of protective coatings as well as hard coatings, such as Ni–Cr–Si–B–Fe, Cu–Zn–Sn–Ni, Ni–Cr–Si–B, Ni–Cu–B, and Co–Cr–B–Si–W is described. (Corrosion Abstr.)

31483 CHEMICAL METHODS FOR THE PRODUCTION OF REACTIVE AND REFRACTORY METAL POWDERS. Sundaram, C. V.; Gupta, C. K.; Bose, D. K.; Krishnan, T. S. (Bhabha Atomic Research Centre, Trombay, India). pp 1-22 of Proceedings of the Symposium on Powders and Sintered Products. Bombay; Dept. of Atomic Energy (1971).

From Symposium on powders and sintered products; Kanpur, India (31 Jan 1971). See CONF-710118.

Chemical and electrochemical methods for the production of metal powders are critically surveyed, and the results of investigations carried out at the Bhabha Atomic Research Center on the production of zirconium, niobium, and tantalum metal powders are presented. The processes discussed include reduction of metal oxides and halides, hydriding-dehydriding of sponge metal, and fused salt electrolysis. (P.C.H.)

31484 POWDER METALLURGY OF NIOBIUM AND TANTALUM. Kamat, G. R.; Taneja, A. K.; Gupta, C. K. (Bhabha Atomic Research Centre, Trombay, India). pp 191-208 of Proceedings of the Symposium on Powders and Sintered Products. Bombay; Dept. of Atomic Energy (1971).

From Symposium on powders and sintered products; Kanpur, India (31 Jan 1971). See CONF-710118.

Powder metallurgical methods are extensively in use for the consolidation and purification of niobium and tantalum metal powder products resulting from metal reduction steps. In fact, powder metallurgy is the only possible technique for some special applications, the production of porous sintered tantalum anodes being a case in point. Work carried out at Bhabha Atomic Research Center on the powder metallurgy processing of niobium and tantalum is described. Results on the vacuum sintering of niobium powders obtained by calcium and calcium hydride reductions are presented. As regards tantalum powder processing, the main interest is for the manufacture of tantalum capacitors, for which a great demand exists in India. The various processing steps that have been standardized at Trombay for the manufacture of porous tantalum slugs are described. The various steps involve initial powder conditioning, grading and blending, compacting to suitable sizes, and finally vacuum sintering in a tantalum resistance furnace. Based on these studies, a production facility for tantalum capacitors equivalent to 1 ton/year is currently under establishment at Hyderabad. (auth)

31485 SINTERING OF COPPER–SILVER–CADMIUM CONTACTS. Nikiforov, O. A. (Indian Inst. of Tech., Kharagpur); Chang Than Nya. pp 209-17 of Proceedings of the Symposium on Powders and Sintered Products. Bombay; Dept. of Atomic Energy (1971).

From Symposium on powders and sintered products; Kanpur, India (31 Jan 1971). See CONF-710118.

Copper–1.2% cadmium contacts have been made for some time by conventional casting as well as by powder metallurgy processes. Cadmium improves the strength properties, tarnish, wear, and fatigue resistances of copper and raises its recrystallization temperature. At the same time the loss in electric and thermal conductivities due to alloying are only marginal. Production of this material, however, creates the problem of loss of cadmium due to evaporation at the sintering temperatures for copper. A sintering technique with protective cover and under pressure of inert atmosphere has been studied. The sintering of 5% Ag–1% Cd–Cu contacts, in autoclaves at 900°C is described. It was found that external pressures of argon up to 8.6 atmospheres did not in anyway reduce the cadmium loss. Hence it was necessary to provide sufficient cadmium partial pressures in the atmosphere to eliminate evaporation losses. This can be done by a cover of cadmium bearing materials which dissociate at sintering temperatures. CdO is an economical covering material which dissociates around 700 to 800°C. The amount of the cover material of Al_2O_3–1% CdO to prevent evaporation losses of cadmium seems to be determined by the volume of the hot zone in the autoclave. (auth)

31486 DEVELOPMENT OF TUNGSTEN–SILVER COMPOSITES FOR USE AS ELECTRICAL CONTACTS. Kantan, S. K.; Pai Bhale, S. V.; Raghavan, R. V.; Rao, N. K. (Bhabha Atomic Research Centre, Trombay, India). pp 218-34 of Proceedings of the Symposium on Powders and Sintered Products. Bombay; Dept. of Atomic Energy (1971).

From Symposium on powders and sintered products; Kanpur, India (31 Jan 1971). See CONF-710118.

Tungsten–silver composites are widely used as heavy-duty electric contacts in industry. These are being imported and hence attempts were made to develop these composites using indigenous raw materials. Composites were produced by two methods: preparing porous tungsten and then infiltrating the porous skeleton with silver; and compaction of tungsten and silver powders of required composition into discs followed by sintering. The composites made by infiltration technique compared favorably with the imported ones. (auth)

Properties, Structure, and Phase Studies

Refer also to abstracts 30958, 30966, 30967, 30974, 31397, 32704, and 32715.

31487 (CEA-R-4266) CONTRIBUTION TO THE STUDY OF THE SPECIFIC HEAT OF ACTINIDE COMPOUNDS. Affortit, Christian (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1972. 91p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Faculte des Sciences, Univ. of Paris, Orsay, France.

A method was devised for measuring the specific heat of refractory metals and ceramic nuclear compounds up to their melting point. A rapid dc heating method was used and extended to semiconductor nuclear compounds like uranium and plutonium oxides. The $(UPu)O_{2\pm x}$ system has been extensively investigated, in particular with respect of the variation of specific heat versus temperature, oxygen to metal ratio, and plutonium to uranium ratio. For all the compounds investigated, both metals and ceramics, a very important rise in specific heat was observed near their melting point; an attempt for a theoretical analysis of this phenomenon is presented. (62 references) (auth)

31488 (KFK-1512) CREEP BEHAVIOR AND TIME TO RUPTURE OF THE ALLOY X8CrNiMoNb 1616 FOR VARIOUS PRETREATMENTS. Boehm, H.; Schirra, M.; Solano, R.; Garcia, R. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Dec 1971. 75p. (In German). Dep. NTIS (U. S. Sales Only).

In order to study the influence of different thermomechanical treatments on the creep behavior and time-to-rupture of stainless steel X8 CrNiMoNb 1616 (DIN 1.4981) samples of five different pretreatments were investigated in the temperature range 600 to 800°C. Starting with solution treated material (as obtained from the manufacturers) it was found that annealing at 700 and 800°C (Treatment II and III) did not materially affect time-to-rupture. On the other hand time-to-rupture and creep behavior were greatly improved by 12% cold-work (Treatment IV) and by cold-work and annealing at 800°C (Treatment V). This improvement was preserved for temperatures up to 700°C and times up to $>10^4$ hours. The loss of ductility was relatively small. The main effect of treatments IV and V was strengthening of the matrix via cold-work, i.e., the yield point at high temperature was raised. This is an important point to consider for designing fuel element cladding. For this purpose the most important creep data for pretreatments I to V are given for all tests temperatures and a wide range of stresses. The metallographic investigations gave insight into crack formation, fracture, and changes in the grain structure. (auth)

31489 (N-72-14550) REVIEW OF DEFORMATION BEHAVIOR OF TUNGSTEN AT TEMPERATURE LESS THAN 0.2 ABSOLUTE MELTING TEMPERATURE. Stephens, Joseph R. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan 1972. 32p. (NASA-TM-X-2482; E-6500). NTIS.

The deformation behavior of tungsten at temperatures $<0.2\ T_m$ is reviewed, with primary emphasis on the temperature dependence of the yield stress and the ductile-brittle transition temperature. It appears that a model based on the high Peierls stress of tungsten best accounts for the observed mechanical behavior at low temperatures. Recent research is discussed which suggests an important role of electron concentration and bonding on the mechanical behavior of tungsten. It was concluded that future research on tungsten should include studies to define more clearly the correlation between electron concentration and mechanical behavior of tungsten alloys and other transition metal alloys. (auth) (STAR)

31490 (NMAB-275) TRENDS IN THE USE OF DEPLETED URANIUM. (National Materials Advisory Board(NRC), Washington, D. C.). Jun 1971. 184p. NTIS.

Information on uranium and its compounds is presented to assist in assessing the impact of changing technology on their future requirements. The data may stimulate greater interest in the usage of depleted uranium in nonnuclear applications, thus bringing its consumption in closer balance with its supply level. Topical areas include depleted uranium's supply situation, present nonenergy consumption, potential uses, metallurgy, chemistry, and effectiveness as a catalyst and alloying element. Current consumption for nuclear uses is small. The only major area of promise involving large quantities of depleted uranium is in breeder-power reactors where a development program is being supported by Government and industry. However, significant quantities are not expected to be used in breeder reactors until after 1985. Current consumption of uranium for commercial nonnuclear applications is under 500 tons per year, but this consumption is expected to grow as the properties of depleted uranium are exploited. Its high density and ability to form alloys (or to be alloyed) are promising for the development of new applications. Uranium forms stable compounds with many metals and nonmetals. Its valency range from 3 to 6, its amphoteric nature, and its ability to form double and complex salts are particularly interesting in catalytic and other areas. Uranium can be safety fabricated and used with very few special precautions. Education of potential users is needed to remove the fear created by the words "uranium" and "radioactive." Precautions regarding safety hazards should be presented in the same manner as those for materials such as lead, silver, and arsenic. (auth)

31491 (ORNL-TM-3609) STUDY OF THE ADHERENCE OF TUNGSTEN AND MOLYBDENUM COATINGS. Federer, J. I.; Poteat, L. E. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 13p. (CONF-720410-3). Dep. NTIS.

From third international conference on chemical vapor deposition; Salt Lake City, Ut. (24 Apr 1972).

Tungsten and molybdenum coatings on iron- and nickel-base alloys are being investigated as a potential solution to the corrosion problem in Molten Salt Breeder Reactor reprocessing equipment. The adhesion of coatings applied by hydrogen reduction of WF_6 and MoF_6 has been evaluated. Displacement reactions between iron and chromium in the iron-base alloys and the WF_6 and MoF_6 prevented adhesion of the coatings. A thin nickel plate diffusion bonded to the iron-base alloys minimized side reactions and solved the adhesion problem. Both tungsten and molybdenum coatings remained intact after repeated thermal cycling between 25 and 600°C and during a spiral bend test. Tungsten coatings had tensile bond strengths up to 35,000 psi. (auth)

31492 (ORNL-TM-3711) BIAXIAL CREEP-RUPTURE PROPERTIES OF DEFECTIVE STAINLESS STEEL TUBING. King, R. T.; Cook, K. V.; Reimann, G. A. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 60p Dep. NTIS.

Thin-wall 20%-cold-worked Type 316 stainless steel tubing is a candidate fuel cladding material for Liquid Metal Fast Breeder Reactor applications. The effects of well-characterized electrodischarge machined notches on the biaxial stress-rupture properties of such tubing at 650°C are reported. Notches on either the inner or outer surface of tubing reduce the rupture times and apparent ductility. The effects of notch length and depth on properties were determined, and the results analyzed according to theories that deal with stresses near cracks. An approximate steady-state creep model was developed and applied to the results. Design allowances for defects based simply on the remaining wall thickness under the defect are not adequate nor are they conservative for long notches; a notch depth of 10% of the wall thickness can reduce the stress to produce a given rupture time by as much as 25%. (auth)

31493 (ORO-4044-2) MICROSTRUCTURAL STABILITY OF THERMAL-MECHANICALLY TREATED AUSTENITIC STAINLESS STEELS. Progress Report, February 1, 1971-January 31, 1972. Spruiell, Joseph E. (Tennessee Univ., Knoxville. Dept. of Chemical and Metallurgical Engineering). Contract AT(40-1)-4044. 65p. Dep. NTIS.

Studies of the microstructural stability of three austenitic stainless steels are being performed for a wide range of thermal-mechanical pretreatments in the limited aging temperature range of 550 to 750°C. The steels studied include Types 316, 304, and a Ti modified version of Type 316. The pretreatments were selected in order to investigate the effects of varying solution treatment temperature, amount of cold reduction by rolling, initial grain size, and initial precipitate distribution. Both the phase stability and the recovery and recrystallization behavior of cold worked materials are being investigated. Results show that large variations in both phase stability and recrystallization behavior can be effected by appropriate pretreatments. Cold work accelerates precipitation of $M_{23}C_6$ carbide and the intermetallic compounds (Laves, chi, and sigma phases). $M_{23}C_6$ and Laves phase are readily nucleated on deformation bands (dislocations, stacking faults) but sigma requires high energy interfaces such as grain boundaries for nucleation. Both the amount and kinetics of sigma formation are especially enhanced by recrystallization occurring in the aging temperature range. Fine grain size enhances phase instability by providing additional nucleating sites and decreased diffusion paths for precipitate forming elements. In the grain size range studied (ASTM No. 3.5 to No. 13) the effect of grain size changes does not appear to be as significant as the effect of cold work, particularly when recrystallization occurs during aging as a result of the cold work. Fine grain size and treatments which precipitate the carbides prior to the final cold working step enhance recrystallization behavior relative to solution treated and cold worked materials. It is suggested that this behavior is due to stabilization of the cold worked substructure in the solution treated samples by precipitation of carbide and Laves phases on the dislocations and stacking faults. Both recrystallization behavior and phase stability are significantly affected by alloy composition. Preliminary results indicate that the heats of both Type 304 and the Ti-modified Type 316 are more prone to sigma formation than the heat of standard Type 316. The Type 304 material also recrystallizes more readily than the Type 316 materials. These observed differences were tentatively related to differences in carbon and molybdenum content. (auth)

31494 (SCL-TM-720226) MECHANICAL PROPERTIES OF U-2.3 WT. PERCENT Nb HEAT TREATED TO PRODUCE VARIOUS TWO-PHASE STRUCTURES. Zehr, S. W. (Sandia Labs., Livermore, Calif.). Mar 1972. Contract AT(29-1)-789. 31p. Dep. NTIS.

A preliminary study of the mechanical properties of a U-2.3 wt % Nb alloy in various two-phase conditions was made. The work to date indicates that initially soft, ductile and potentially fabricable two-phase conditions of the alloy can subsequently be strengthened by heat treatment and/or cold work to provide properties which will equal or exceed the following: Young's modulus, 20 × 10^6 psi; yield strength (0.2% offset), 120,000 psi; and elongation, 5%. (auth)

31495 (UJV-2719-M) PREFERRED ORIENTATIONS OF HEXAGONAL METALS WITH SUBCRITICAL VALUES OF c/a. Volf, F. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1 Oct 1971. 43p. (In Czech). Dep. NTIS (U. S. Sales Only).

Techniques for the study of preferred orientations in zirconium and magnesium were developed. Area weights for the Harris method have been calculated and equations for the growth index and the thermal expansion coefficient of zirconium have been derived from "p" values of inverse pole figure. The same data also yielded the preferred orientation parameter (analogous with that used for uranium) describing the deviation of texture in both metals from randomness. The techniques were demonstrated on swaged zirconium rods and on magnesium rods extruded at elevated temperatures. Inverse pole figures and the dependences of calculated quantities on the amount of reduction are given. (auth)

31496 STRESS-DEPENDENCE OF HIGH TEMPERATURE CREEP OF TUNGSTEN AND A TUNGSTEN-2 WT. PERCENT ThO_2 ALLOY. King, G. W. (Westinghouse Electric Corp., Bloomfield, N. J.). Met. Trans.; 3: No. 4, 941-5(Apr 1972).

Constant-load creep tests were conducted with pure tungsten and a W-2 wt % ThO_2 alloy at temperatures between 1600 and 2200°C and at strain rates of about 1×10^{-8} to 4×10^{-5} sec^{-1}. The results were evaluated by the empirical correlations of Robinson and Sherby and also Mukherjee et al. which describe the stress dependence of the creep of metals and alloys. The agreement of the experimental data with the earlier correlations was found to be poor. However, when the following empirical relationship was used: $\dot{\epsilon}_c = A'(\sigma_c/\sigma_f)^n$, the creep data for tungsten and the tungsten alloy at various temperatures were much better correlated. Here, $\dot{\epsilon}_c$ is the experimental creep rate, σ_c is the applied stress for creep, σ_f is the flow stress of the material at the same temperature in a constant strain rate tensile test, and A' is function of temperature, structure, and strain rate. (auth)

31497 NONCRYSTALLINE Pt-Sb PHASE AND ITS EQUILIBRATION KINETICS. Srivastava, P. K.; Giessen, B. C.; Grant, N. J. (Massachusetts Inst. of Tech., Cambridge). Met. Trans.; 3: No. 4, 977-82(Apr 1972).

Utilizing splat cooling, a metastable noncrystalline phase was obtained in Pt-Sb alloys with 30 to 43% Sb and in Pt-Si alloys with the eutectic composition Pt-68% Si. These nonequilibrium structures can be retained indefinitely at room temperature. The kinetics of the decomposition of the metastable noncrystalline phase in a Pt-34% Sb alloy was studied in detail by x-ray diffraction, electron diffraction, and electron transmission microscopy. The decomposition starts at an appreciable rate at about 210°C, and progresses gradually with the precipitation of relatively equiaxed grains of crystalline phases. From isothermal kinetic data, average activation energies from 55.5 to 49.5 (±4) kcal per mole were derived for the overall decomposition process. (auth)

31498 CHEMICAL DIFFUSION IN THE β PHASE OF THE Zr–Ti ALLOY SYSTEM. Raghunathan, V. S.; Tiwari, G. P.; Sharma, B. D. (Bhabha Atomic Research Centre, Trombay, India). Met. Trans.; 3: No. 4, 783-8(Apr 1972).

Interdiffusion studies have been carried out in the bcc phase of the Zr–Ti alloy system using diffusion couples of zirconium and Zr–Ti alloys. Geoscan electron microprobe was employed to establish the concentration-penetration profiles in the diffusion zones, and the interdiffusion coefficients were evaluated by Boltzmann–Matano analysis. The concentration and temperature dependence of the diffusivity have also been examined. Results of studies further showed that the diffusivity in the Zr–Ti system β-phase could be expressed by an equation similar to that given by Vignes and Birchenall for vacancy-controlled interdiffusion in fcc solid solutions. (auth)

31499 MECHANICAL PROPERTIES OF DIFFUSION-BONDED BERYLLIUM INGOT SHEET. **Heiple, Clinton R.** (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Met. Trans.; 3: No. 4, 807-12(Apr 1972).

A technique for producing thick beryllium plate from ingot source material by diffusion-bonding together thin sheets is described. The bonds produced are at least as strong as the matrix, and are produced under conditions where no significant grain growth occurs. The laminated plate has better mechanical properties than the sheet from which it was made, and properties substantially superior to sheet of similar thickness rolled directly from the ingot. Room temperature tensile elongations of approximately 18% were observed in the laminated plate. Directly rolled plate of similar thickness normally exhibits 2 to 4% elongation, and the sheet from which the laminate was made failed after about 12% elongation. The increased ductility of the laminate is a consequence of the compressive creep deformation accompanying bonding and most likely results from a dislocation substructure, produced by the deformation, which differs from the substructure developed by annealing. (auth)

31500 USEFULNESS OF PRECRACKED CHARPY SPECIMENS FOR FRACTURE TOUGHNESS SCREENING TESTS OF TITANIUM ALLOYS. **Ronald, T. M. F.; Hall, J. A.; Pierce, C. M.** (Air Force Materials Lab., Wright-Patterson AFB, Ohio). Met. Trans.; 3: No. 4, 813-18(Apr 1972).

Although the K_{Ic} value of a material is a very useful measure of fracture toughness, its valid experimental determination can be a complex and expensive procedure, not at present suited to routine alloy screening or quality control purposes. To explore the feasibility of estimating K_{Ic} in titanium alloys using techniques that are more convenient to perform, impact and slow-bend tests were made on either V-notched or fatigue-precracked Charpy specimens, and the resulting energy values were compared with the corresponding approximate K_{Ic} values. Of the various tests studied, results from five titanium-based alloys, two steels, and two aluminum alloys showed that precracked specimens broken in slow-bend hold the most promise of giving energy values that can be related to K_{Ic}. The best correlation came from specimens having mostly flat fractures, but in the higher-toughness cases, where shear lips of an appreciable size were formed, just as reasonable a relationship between energy and K_{Ic} was observed when flat-fracture energies were used. (auth)

31501 DIFFUSION IN TERNARY Ag–Zn–Cd SOLID SOLUTIONS. **Carlson, P. T.; Dayananda, M. A.; Grace, R. E.** (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1436. Met. Trans.; 3: No. 4, 819-26(Apr 1972).

Diffusion in the Ag–Zn–Cd system was investigated at 600°C with semi-infinite, vapor-solid couples in order to evaluate intrinsic diffusion coefficients and interdiffusion coefficients in the α and β phases. Intrinsic diffusion coefficients were determined at several composition points in the α-phase region along concentration lines of 11 at. % Zn, 18 at. % Zn, 5 at. % Cd, and 9 at. % Cd. Interdiffusion coefficients in the α phase were determined at several points of intersection of various composition paths; these composition points of intersection were along lines of constant zinc-to-cadmium concentration ratios of 3.8, 1.8, and 1.2. All two-phase diffusion couples developed planar β/α interfaces. Intrinsic coefficients were computed at three composition points in the β region corresponding to a silver concentration of approximately 55 at. %. Intrinsic coefficients for β alloys are two to three orders of magnitude larger than those for α alloys. (auth)

31502 DEFORMATION MECHANISMS OF SUPERPLASTICITY. **Hayden, H. W.; Floreen, S.; Goodell, P. D.** (International Nickel Co., Suffern, N. Y.). Met. Trans.; 3: No. 4, 833-42 (Apr 1972).

Under various conditions of stress and temperature various deformation mechanisms could be rate-controlling for superplastic deformation. At low stresses, diffusion creep should be rate-controlling. At temperatures between approximately 40 and 65% of the absolute melting point, grain boundary diffusion should be the dominant diffusion path while at higher temperatures volume diffusion should dominate. At intermediate stresses, grain boundary sliding should be the major deformation mode, but the sliding rate should be governed by the lesser rate of dislocation creep within the grains. At temperatures between 40 and 65% of the melting point, the rate of dislocation creep should be controlled by dislocation pipe diffusion, while at higher temperatures volume diffusion should be rate-controlling. At high stresses the superplastic effect of unusually large tensile extensibility should diminish due to the greater possibility of work-hardening processes such as dislocation cell, tangle, and pile-up formation. (auth)

31503 TEMPERATURE INDEPENDENT PLATEAU STRESS OF SOLID SOLUTION CRYSTALS. **Boser, O.** (GTE Labs., Inc., Bayside, N. Y.). Met. Trans.; 3: No. 4, 843-9(Apr 1972).

A calculation of the plateau stress in solid solution crystals is presented in which an arbitrarily oriented dislocation loop of length L, that moves under an applied stress, is assumed. At high concentrations of solute atoms the dislocation segment does not interact with an individual solute atom but instead with all the solute atoms along the dislocation segment within a certain radius. The macroscopic flow stress is assumed to be determined by the maximum force that is encountered when a dislocation is moved over a distance equal to the distance between the position at zero stress and the critical position of an activated Frank–Read source. If the dislocation segment is assumed to be large compared with atomic distances, the interaction with groups of atoms will lead to an athermal process and therefore can explain the origin of the temperature independent flow stress in solid solution crystals. From this model the flow stress can be calculated with the help of statistical methods similar to those used in calculations of the movement of Bloch walls in magnetic materials. Besides the proper temperature dependence of the plateau stress, the model yields a dependence of the plateau stress upon the square root of the solute concentration, a result that is in good agreement with the measurements on silver, gold, and copper-based alloys. A linear relation between the solid solution hardening parameter $d\tau/a\sqrt{C}$ and the strength of the solute atoms is obtained which is confirmed by the experimental results on copper-based alloys. (auth)

31504 PHASE INSTABILITIES DURING HIGH TEMPERATURE EXPOSURE OF 316 AUSTENITIC STAINLESS STEEL. **Weiss, B.** (Westinghouse Research Lab., Pittsburgh); **Stickler, R.** Met. Trans.; 3: No. 4, 851-66(Apr 1972).

Although Type 316 austenitic stainless steel is widely used in steam generating plants and nuclear reactors, the knowledge about aging reactions, nature of precipitates, and precipitation kinetics during high temperature exposure is limited. Time-temperature-precipitation (TTP) diagrams were determined between 400 and 900°C for up to 3000 h as a function of carbon content, solution treatment temperature, and cold work. The nucleation and growth phenomena, morphology, and composition of the various carbide ($M_{23}C_6$, M_6C) and intermetallic phases (σ, χ, η) were determined. The complex sequence of phase instabilities can be explained on the basis of the carbon content, effect of molybdenum and chromium on the carbon solubility, thermodynamic stability of the phases, and the kinetics of the various precipitation reactions. (auth)

31505 HIGH-TEMPERATURE CREEP BEHAVIOR OF NICKEL-RICH Ni–W SOLID SOLUTIONS. **Johnson, W. R.; Barrett, C. R.; Nix, W. D.** (Stanford Univ., Calif.). Contract AT(04-3)-326 PA 17. Met. Trans.; 3: No. 4, 963-9(Apr 1972).

The steady-state creep behavior of four nickel-rich Ni–W solid solutions (1, 2, 4, and 6 wt % W) was investigated in the temperature range 850 to 1050°C. Constant stress tensile creep tests were performed in vacuum in the stress range 3000 to 7000 psi. Activation energies for creep were observed to be 71.4 ± 2.0, 74.4 ± 3.0, and 75.8 ± 2.0 kcal per mole, after correcting temperature dependence of the elastic modulus for alloys containing 2, 4, and 6% W respectively. These values closely approximate the activation energies for the weighted diffusion coefficient, $\overline{D} = D_{Ni}D_W/(X_WD_{Ni} + X_WD_{Ni})$ where X_{Ni} and X_W are the atom fractions of nickel and tungsten respectively, and D_{Ni} and D_W are the diffusion coefficients of nickel and tungsten in the alloy. The steady-state creep rates exhibit a power law stress dependence with an exponent, n, equal to 4.8 ± 0.2 for all of the alloys studied. For tests conducted at temperatures and stresses such that both the diffusivity, $\overline{D}$, and the ratio of the applied stress to the elastic modulus, σ/E, are held constant, the steady-state creep rate, $\dot{\epsilon}_s$, was found to vary with the stacking fault energy, γ, according to the empirical relation $\dot{\epsilon}_s \sim \gamma^{4.2 \pm 0.4}$ over the range of creep rates studied. (auth)

31506 DENSITIES AND VISCOSITIES OF SOME LIQUID ALLOYS OF ZINC AND CADMIUM. Crawley, A. F. (Dept. of Mines and Resources, Ottawa). Met. Trans.; 3: No. 4, 971-5 (Apr 1972).

The densities and viscosities of the alloy systems Zn–Sn, Cd–Sn, and Cd–Pb and of zinc- and cadmium-rich Zn–Pb and Cd–Tl alloys have been determined accurately by absolute techniques of proven reliability. Isothermal molar volumes for all five systems show positive deviations from ideal mixing in agreement with other published data. Isothermal viscosity data demonstrate large negative deviations from ideal mixing. In each system, solute additions give rise to sharp decreases in viscosity at the zinc- and cadmium-rich ends of the system, a phenomenon not reflected in the density data. To explain the viscosity results, it is proposed that alloying additions to zinc and cadmium alter the interatomic bonding associated with the surface structure of these metals causing disproportionate viscosity changes. Results of recent surface tension studies have aptly demonstrated that the surfaces of zinc and cadmium are atomically more ordered than the bulk metal. (auth)

31507 INFLUENCE OF MOLYBDENUM ON THE γ′ PHASE IN EXPERIMENTAL NICKEL-BASE SUPERALLOYS. Loomis, W. T. (Logic Associates, Inc., Hanover, N. H.); Freeman, J. W.; Sponseller, D. L. Met. Trans.; 3: No. 4, 989-1000(Apr 1972).

The influence of 1, 3, and 5 at. % Mo on the γ′ precipitate has been studied in experimental wrought nickel-base superalloys containing about 14 at. % Cr and 6½, 9, or 12 at. % Al, or 2 at. % Al plus 4 at. % Ti. Concentrations of all other elements were low to limit the observed effects to those of molybdenum alone. Molybdenum markedly increases the γ′ solvus temperature, as determined by the sensitive and relatively simple technique of differential thermal analysis; correspondingly, the weight fraction of γ′ increases with molybdenum additions for a given aging treatment. Molybdenum dissolves extensively in the γ′ of the titanium-free alloys, but it dissolves to a considerably smaller extent in the γ′ of the titanium-bearing alloys. Molybdenum substitutes for chromium in γ′, but does not alter the aluminum or titanium contents of this phase. Lattice parameters of both the matrix and the γ′ are increased markedly by molybdenum, in proportion to the molybdenum contents of these phases. The resulting effects on lattice-parameter mismatch correlate well with the observed γ′ morphology, which tends to change from spheroidal to cuboidal in titanium-free alloys, and from cuboidal to spheroidal in 2 at. % Al–4 at. % Ti alloys, as molybdenum is added to these alloys. (auth)

31508 EFFECT OF MOLYBDENUM ON THE DIFFUSION OF ALUMINUM AND TITANIUM FROM $Ni_3(Ti,Al)$ INTERMETALLIC COMPOUNDS INTO A Ni–Mo MATRIX. Bridge, J. Edwin Jr.; Maniar, Gunvant N. (Carpenter Tech. Corp., Reading, Pa.). Met. Trans.; 3: No. 4, 1005-7(Apr 1972).

The diffusion coefficients are compared with coefficients for a pure Ni matrix. Included results show that Mo retards the diffusion of Al and Ti from $Ni_3(Ti, Al)$ into the Ni–Mo matrix. It also appears that Mo does not readily diffuse in $Ni_3(Ti, Al)$. (J.R.D.)

31509 HIGH TEMPERATURE POROSITY IN TUNGSTEN. Brett, J. (General Telephone and Electronics Labs., Bayside, N. Y.); Friedman, S. Met. Trans.; 3: No. 4, 769-78(Apr 1972).

A study of the development of porosity in the temperature range of 3000 to 3350°C in several grades of tungsten wire was performed. In addition to measurements of the kinetics of pore growth and pore number density by light microscopy, examinations on heat-treated wire by means of scanning electron microscopy and electron fractography were accomplished and revealed submicron-sized pores principally arranged in linear arrays. The observations were evaluated in terms of various theories of pore growth. While the phenomena encountered were complex and overlapping, it seems probable that initial pore growth is by plastic deformation due to volatilization of dopant. The constancy of the number of growing microscopic-sized pores with time suggests that coalescence processes are not rate controlling. Since an activation energy of 110 kcal per mole was measured for pore growth in doped tungsten, vacancy diffusion from the surrounding matrix to the pore under internal pressure was considered. A simplistic analytic treatment yielded a ⅕ power-time dependence in comparison with the linear relation observed. (auth)

31510 INTERNAL FRICTION STUDY OF Ni_4Mo. Ling, Fu-wen; Collado, J.; Starke, E. A. Jr. (Georgia Inst. of Tech., Atlanta). Contract AT(40-1)-3908. Scr. Met.; 6: No. 4, 307-10(Apr 1972).

Wire samples were prepared from Ni_4Mo and treated to produce various degrees of order and antiphase domain sizes. Internal friction measurements were made using a $2-H_z$ free torsional pendulum. The dislocation density was calculated using measured strains. The results are presented graphically and in tables. (J.R.D.)

31511 FURTHER COMMENTS ON THE ENTROPY OF THERMALLY ACTIVATED PLASTIC DEFORMATION AT LOW TEMPERATURES. Arsenault, R. (Univ. of Maryland, College Park). Contract AT(40-1)-3612. Met. Trans.; 3: No. 4, 1014-15(Apr 1972).

Experimental data are presented which show that the entropy coefficient for low temperature deformation is zero or has a small positive or negative value. Data are included on dislocation velocity vs stress of Mo, and low-temperature slip activation energy for Mg. (J.R.D.)

31512 EFFECTS OF TEMPERATURE AND PURITY ON THE SECOND STAGE OF HARDENING IN POLYCRYSTALLINE α-TITANIUM. Arunachalam, V. S. (National Aeronautical Lab., Bangalore, India); Pattanaik, S.; Monteiro, S. N.; Reed-Hill, R. E. Met. Trans.; 3: No. 4, 1009-11(Apr 1972).

Work hardening in polycrystalline Ti at low temperatures was studied. It was found that impurities and temperature affect the work hardening rates in this material. It also appears that the formation of dislocation cells leads to changes in work hardening. Data are presented graphically. (J.R.D.)

31513 ACTIVATION ENERGY AND SATURATION DENSITY FOR In AND Sn THIN FILMS ON NaCl SUBSTRATES. Singh, H. P.; Murr, L. E. (Univ. of Southern California, Los Angeles). Contract AT(04-3)-113. Scr. Met.; 6: No. 4, 333-7(Apr 1972).

Results of island density of In and Sn films deposited on NaCl are presented along with results of calculations of activation energies for diffusion, desorption, and saturation density. Results show that island density in the substrate temperature range of 25 to 130°C increases from 25 to 65 for In and 25 to 45°C for Sn after which it decreases in each case with further increase in temperature. Mechanisms controlling island density are discussed. (J.R.D.)

31514 HIGH-TEMPERATURE SOLUBILITY OF NITROGEN IN RHENIUM. Jehn, H.; Hohloch, K.-D.; Fromm, E. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Less-Common Metals; 27: No. 1, 98-100(Apr 1972). (In German).

The solubility of nitrogen and rhenium was studied in a high vacuum apparatus with wire samples of 1mm diameter. In a nitrogen atmosphere, the samples were heated up to 2750°C and subsequently degassed at 1400 to 1900°C. For the mixed rhenium–nitrogen crystals, the formula is given together with heat and entropy of solution. Also presented is the diffusion coefficient of nitrogen and rhenium with its dependency on temperature. (H.B.G.)

31515 INFLUENCE OF STABILIZING α- AND β-ELEMENTS ON THE POSITION OF PHASE BOUNDARIES IN THE TITANIUM–ALUMINUM SYSTEM. Korniloy, I. I.; Tavadze, F. N.; Ronami, G. N.; (and others) (Inst. of Metallurgy, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 66: No. 1, 133-6(Apr 1972). (In Russian).

The influence of oxygen, zirconium, and vanadium on the solubility of aluminum in α-Ti was studied by the method of diffusion layers. Oxygen and zirconium are shown to decrease the solubility of aluminum in α-Ti, whereas vanadium has no marked influence on the solubility. (auth)

31516 SHOCK MELTING AND VAPORIZATION OF METALS. Ahrens, Thomas J. (California Inst. of Tech., Pasadena). J. Appl. Phys.; 43: No. 5, 2443-5(May 1972).

The effect of initial porosity on shock induction of melting and vaporization was investigated for Ba, Sr, Li, Fe, Al, U, and Th. For the less compressible of these metals, it was found that for a given strong shock-generation system (explosive in contact, or flyer-plate impact) an optimum initial specific volume exists such that the total entropy production, and hence the amount of metal liquid or vapor, is a maximum. Initial volumes from 1.4 to 2.0 times crystal volumes, depending on the metal sample and shock-inducing system, will result in optimum postshock entropies. (auth)

31517 EFFECTS OF HYDROGEN AND OXYGEN ON THE DEFORMATION AND FRACTURE OF REACTOR-GRADE HAFNIUM. Straw, Raymond L. Troy, N. Y.; Rensselaer Polytechnic Inst. (1971). 313p. University Microfilms Order No. 72-10,869.

Thesis.

The effects of hydride precipitates and oxygen solid solutions on the tensile deformation and fracture behavior of reactor-grade hafnium at low temperatures were examined. Metallurgical structure was characterized by using optical and transmission electron metallography and Laue back reflection x-ray techniques. Fracture surfaces were examined using a scanning electron microscope. The existence of basal hydride habit planes in hafnium was confirmed. At slow cooling rates (equivalent to air cooling) $\{10\bar{1}0\}$ prismatic in addition to (0001) basal hydride habit planes were present. Samples rapidly cooled by water-spray-quenching had only basal hydride precipitates present. Additions of oxygen solid solutions and fine hydride precipitates produced by water-spray-quenching increased the yield strength of hafnium. At identical alloy levels oxygen additions were more effective in strengthening. The strengthening effect of hydride precipitates exhibited a plateau with increasing hydrogen. This yield plateau began at lower hydrogen concentrations as the test temperature was decreased. Cross slip of prismatic screw dislocations to the basal plane and past the basal hydride precipitates is responsible for the yielding plateau. Cross slip in hafnium can be eliminated by oxygen additions, thereby eliminating the plateau. Although no macroscopic cleavage was confirmed for zirconium, cleavage on the basal plane was identified in hafnium tested at 4.2 and 13°K. Curved cracks with indeterminate indices predominate at those test temperatures indicating cleavage on many planes. Alloying, microstructure, and test variables affect cleavage in hafnium. A qualitative estimation of such variables was made by modifying the Cottrell—Petch fracture theory. The effects of variables in this investigation were inferred from this modified brittle fracture criterion. The occurrence of brittle fracture was enhanced by increasing the yield strength, critical resolved shear stress (CRSS) for slip on secondary systems, and grain size or by decreasing the fracture surface energy. The yield strength can be increased by both fine hydride precipitates and oxygen solid solutions or by decreasing the test temperature. The CRSS for secondary slip is increased by additions of oxygen in solid solution. The fracture surface energy of hafnium can be decreased by the formation of iron-rich films on the grain boundaries or by the precipitation of excessive amounts of hafnium hydrides on the grain boundaries. (Diss. Abstr. Int., B)

31518 MECHANICAL BEHAVIOR OF POWDER METALLURGY ZINC AND ZINC-TUNGSTEN PARTICULATE COMPOSITES. Edwards, Glen Robert. Stanford, Calif.; Stanford Univ. (1971). 154p. University Microfilms Order No. 72-11,538.

Thesis.

A fundamental understanding of the mechanical behavior of zinc—tungsten particulate composites was sought. Zinc-based particulate composites containing up to 28 v/o tungsten in the form of 1-μ particulates were prepared by powder metallurgy methods. The compression test (constant crosshead speed) was the primary mode of experimental testing. Techniques of metallography and x-ray diffraction were also employed to study behavior as a function of processing, composition, strain rate, and temperature. Strain-softening is associated with a crystallographic texture change occurring in the zinc matrix during deformation. Large fractions of the sample's basal planes, originally parallel to the compression axis, are reoriented by deformation twinning to positions where basal slip can easily occur during compression. The macroscopic strength of the sample thus peaks when twinning begins, and decreases monotonically as the twinned volume increases with strain. At strain rates from 10^{-2} to 3 min^{-1}, composites containing more than 13 v/o tungsten are characterized by: particle strengthening below ~0.3 TM (Zn) and above ~0.7 Tm (Zn) [Tm (Zn) = zinc melting point]; steady-state deformation at temperatures above ~0.3 Tm (Zn); particle weakening between ~0.3 Tm (Zn) and ~0.7 Tm (Zn); an insensitivity of the flow stress to changes in strain rate or temperature, especially between ~0.6 Tm (Zn) and ~0.8 Tm (Zn). It is proposed that mobile dislocations, generated at particle-matrix interfaces by local stress concentrations, largely determine the strength of the material. Between ~0.3 Tm (Zn) and ~0.6 Tm (Zn), high diffusivity paths are operative. Because the matrix grain size is small relative to the particle size, new dislocations generated at the particle are absorbed in nearby grain boundary sinks without mutual interaction, and a steady-state dislocation density results. New mobile dislocations are a weakening influence. Between ~0.6 Tm (Zn) and 0.8 Tm (Zn), lattice diffusivity becomes sufficiently rapid to partially relax local stress concentrations at particle-matrix interfaces. This strengthening effect, coupled with the normal weakening effects associated with recovery mechanisms in the matrix, results in a material insensitive to strain rate or temperature. Above ~0.9 Tm (Zn), generation of compatibility dislocations is relatively unimportant. Particles primarily function as material strengtheners in the traditional sense, by requiring dislocations originating at sources in the matrix to climb over or bow around the particles. The generation of mobile compatibility dislocations at particle-matrix interfaces (a process enhanced by a decrease in temperature or an increase in strain rate as opposed to other deformation mechanisms) can explain the large activation energies and strain rate sensitivity coefficients commonly observed during high-temperature deformation of many dispersion-strengthened metals. (Diss. Abstr. Int., B)

31519 NONLINEAR DEFLECTION ANALYSIS FOR COUPLED TUBULAR STRUCTURES. Barinka, L. L. (Babcock and Wilcox Co., Lynchburg, Va.). J. Eng. Ind.; 93: No. 4, 1255-60(Nov 1971).

An analysis is presented for determining the large, transverse deflections of tubular structures that are mechanically coupled at discrete locations along their length. The nonlinearities treated are characteristic of the limiting nature of frictional and spring-type coupling. Tubular structures are analyzed by considering the assembly of tubes to be subdivided into axial segments between adjacent coupling locations. The governing relationships are developed for tubular structures consisting of any number of different types of tubes. The end product is a well-behaved linear system of equations, which is solved under iteration of applied loading for the nonlinear, transverse deflections of each tubular segment. Reactor fuel assemblies are considered for specific examples of coupled tubular structures, and numerical results are compared with experimental measurements of actual assemblies to demonstrate the accuracy of the analysis. (auth)

31520 OMEGA-PHASE FORMATION IN BETA III TITANIUM ALLOY. Min Chung Jon; Fujimura, Hiroshi; De Angelis, R. J. (Univ. of Kentucky, Lexington). Metallography; 5: No. 2, 139-50(Apr 1972).

The kinetics of the formation of the omega phase in the Beta III alloy is followed during aging at 400°C after quenching from 825°C. Electron diffraction patterns indicate that the omega phase forms during the quench. The aging kinetics are those of omega particles that form on quenching and grow to form ellipsoidal shaped particles during this process. After aging 49 hr at 400°C the omega phase makes up greater than 90% of the volume of the material. During the first 20 min of aging a heavy grain boundary precipitate is formed which continues to grow as aging progresses. (auth)

31521 EFFECTS OF TENSION-COMPRESSION CYCLING ON FATIGUE CRACK GROWTH IN HIGH STRENGTH ALLOYS. Crooker, T. W. (Naval Research Lab., Washington, D. C.). J. Eng. Ind.; 93: No. 4, 893-904(Nov 1971).

Crack growth by low-cycle fatigue is a potential failure mechanism for welded pressure vessels. Residual stresses remaining from fabrication or caused by localized plastic deformation incurred in shakedown can result in operating stress cycles approaching fully-reversed tension-compression. However, virtually all of the fatigue crack propagation data reported in the literature for structural alloys are generated under simple, zero-tension cycling, and their direct application to such problems is questionable. The results of a study which shows that the compression portion of fully-reversed tension-compression cycling can contribute substantially to fatigue crack growth rates in plate thickness medium-to-high strength alloys are presented. Data from several alloys show a 50 percent increase in fatigue crack growth rates due to tension-compression cycling. The implications of these findings and methods for applying the results of this study are discussed. (auth)

31522 EXPERIMENTAL STRESS ANALYSIS OF 24-IN. TEES. Hayes, J. K.; Roberts, B. (Combustion Engineering, Inc., Chattanooga). J. Eng. Ind.; 93: No. 4, 919-28(Nov 1971).

The experimental stress analysis and low-cycle fatigue test of one 24-in. dia, schedule 40 carbon steel, ASA Standard B16.9 tee is described. The tee was instrumented with 230 rectangular strain gage rosettes. Elastic data was obtained for 12 loading conditions consisting of internal pressure and orthogonal pure moment and orthogonal direct forces applied individually to the free branch and run ends of the tee. One of the run ends of the tee was "built in" throughout the test. All loads were applied through pipe extensions welded to the tee. The tee was tested to failure in a low cycle fatigue test with an in-plane bending moment on the branch pipe. The tee was pressurized to the design pressure of 1025 psig during the fatigue test. A cyclic stress of approximately ±83,600 psi was imposed on the tee and a through-the-wall fatigue crack occurred at 18,532 cycles. Significant test results are summarized and compared with design values tabulated in the current issue of the Nuclear Power Piping Code, USAS B31.7-1969. (auth)

31523 FATIGUE CRACK GROWTH IN TYPE 316 STAINLESS STEEL AT HIGH TEMPERATURE. Shahinian, P.; Smith, H. H.; Watson, H. E. (Naval Research Lab., Washington, D. C.). J. Eng. Ind.; 93: No. 4, 976-80(Nov 1971).

The dependence of fatigue crack growth rates on range of stress intensity factor in Type 316 stainless steel was investigated over the temperature range of 75 to 1100°F. The data for the most part could be described by a power law relationship. An increase in temperature generally increased crack growth rate for a given ΔK and decreased fatigue life. The dependence of crack growth rate on temperature is not described adequately by an Arrhenius relation over the range investigated. By normalizing ΔK with respect to Young's modulus, E, the crack growth for the various temperatures tend to fall within a single band. (auth)

31524 DIFFUSION IN THE SYSTEM Mo–Si. Zmii, V. I.; Seryugina, A. S. (Physical-Technical Inst., Kharkov). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 10, 1547-50(Oct 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 10, 1730-4(Oct 1971).

Studies were made on the kinetics of the diffusive saturation of Mo surfaces by Si under quasistationary conditions. At all temperatures studied, 1200 to 1350°C, the diffusion layer consisted of two phases: a thin layer of Mo_5Si_3 next to the Mo and a predominantly thick layer of $MoSi_2$. The character of the diffusion layer structures confirmed the fact that in the system Mo–Si there is predominating bulk diffusion of Si. (P.C.H.)

31525 STUDY OF THE TEMPERATURE-RATE DEPENDENCE OF THE STRENGTH AND PLASTICITY CHARACTERISTICS OF LUTETIUM. Solenov, V. M.; Skudnov, V. A.; Sokolov, L. D.; Gladkikh, A. N. (Gorky Polytechnical Inst., USSR). Probl. Prochnosti; No. 8, 61-3(Aug 1971). (In Russian).

A technique is described for studying the effects of temperature-rate factors on the strength and deformation characteristics of lutetium. Samples for tensile testing had a diameter of 1.5 mm and a working length of 8 mm, and samples for sag tests had a diameter of 1.5 mm and a height of 0.25 mm. Experiments were conducted at temperatures of –80, 110, 304, 497, 689, and 882°C and at various deformation rates (4.10^{-3}, 2.10^{-2}, 2.10^{-2} sec^{-1}); destruction tests were conducted at temperatures of –80, 304, 497, and 689°C with a deformation rate of 2.10^{-2} sec^{-1}. Samples were deformed in an argon medium and the experiments were conducted after holding for 10 to 15 min at a given temperature. The device used for the sag tests is described. Graphs of the deformation of lutetium at different temperatures and rates of deformation showed that the strength rose with a drop in temperature and with an increase in the deformation rate. The temperature dependence of the stress σ showed a nonmonotonic graph with a hump at the deformation aging temperature. The studies showed the possibility of the plastic working of Lu over a wide temperature range by using soft deformation techniques. It was noted that a purer metal should have even higher plasticity. (JPRS)

31526 OPERATION OF DISLOCATIONS WITH (c + a) TYPE BURGERS VECTOR DURING THE DEFORMATION OF ZIRCONIUM SINGLE CRYSTALS. Tenckhoff, Erich (Oak Ridge National Lab., Tenn.). Z. Metallk.; 63: No. 4, 192-7(Apr 1972).

Crystallographically oriented zirconium single crystals were deformed in restraint at different temperatures. Foils taken from the shear plane were examined in the electron microscope by means of contrast experiments with change of the reflecting net plane. Dislocations with $\langle 11\bar{2}3\rangle$ type Burgers vector were found and their number increased with higher deformation temperatures. Trace analysis of distinct dislocation bands with (c + a) type Burgers vector led to the conclusion that $\{11\bar{2}1\}$ and $\{10\bar{1}1\}$ are possible slip planes. The results are in agreement with the formation and stability of texture in rolled zirconium. (auth)

31527 DIFFUSION IN THE SYSTEM Mo–Pd STUDIED BY MEANS OF ELECTRON-PROBE-MICROANALYSIS. Zaiss, Werner; Steeb, Siegfried; Krabichler, Traudl (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk.; 63: No. 4, 180-4(Apr 1972). (In German).

Diffusion processes (1000 to 1600°C) were investigated by means of quantitative electron-probe-microanalysis in the system Mo–Pd. The results showed that the position of the solubility-curve at the Pd-rich side of the system should be a little changed. All over the system volume-diffusion could be observed. The chemical diffusion coefficient D was measured in its dependency from temperature and concentration as well as the activation energy. Also the temperature dependency of the intrinsic diffusion coefficients D_{Pd} and D_{Mo} was obtained at the original interface. The activation energy Q_{Pd} and Q_{Mo} at this concentration also was determined. (auth)

31528 EFFECT OF SIZE IN POWDER-METALLURGY HARD ALLOYS OF THE TUNGSTEN GROUP. Loshak, M. G.; Fridman, V. M. (Inst. of Ultrahard Materials, Kiev). Probl. Prochnosti; No. 8, 43-7(Aug 1971). (In Russian).

The effects of the dimensions of hard-alloy samples and the technique of fabricating them on the static and dynamic strength characteristics of alloys with varying contents of cobalt and different elastic-plastic properties were studied. Medium-grain alloys with a Co content of 6, 15, and 25 wt % were studied. This choice was due to the wide use of VK6, VK15, and VK25 alloys and the possibility of studying alloys with different elastic-plastic properties in order to obtain data characterizing the role of the scale effect for all alloys of the tungsten group. The characteristics of the cyclic strength under shock and harmonic loading were also studied in addition to determining the static strength and strength under a single shock because of the known great sensitivity of the fatigue tests to the scale effect. The smaller samples had dimensions of 3.75 × 3.75 × 25 mm, which are close to the dimensions of a standard sample and the largest had dimensions of 15.00 × 15.00 × 100. It was found that a scale effect appears in hard alloys under static and single shock loading and under cyclic shock and harmonic loading. The drop in the strength limit under bending with an increase in the volume of the sample from 300 to 20,000 mm^3 is 40%. The strength of solid parts under static and dynamic loads was measured taking into account the effects of scale on the geometrically similar and structurally identical control samples. An additional change in the strength characteristics is associated with fabrication technology, said to be possible for very large parts of hard alloys. (JPRS)

31529 REACTION DIFFUSION OF GERMANIUM INTO NIOBIUM. Sirota, N. N.; Sokolov, S. N. (Inst. of Solid State Physics and Semi-Conductors, Moscow). Dokl. Akad. Nauk BSSR; 15: No. 10, 881-4(Oct 1971). (In Russian).

The isothermal diffusion of Ge into Nb was studied over the range of temperatures 800 to 1100°C and for time intervals ranging from 5 to 200 hr. Activation energies, diffusion coefficients, and other constants were derived from thickness changes of the samples relative to the annealing time at various temperatures. For diffusion of Ge into Nb, the diffusion coefficient = 4.92×10^{-11} cm^2/sec (near 1100°C), and the activation energy = 57.8 ± 2.9 kcal/mole. (K.S.W.)

31530 CREEP OF METALS UNDER MULTIAXIAL STATES OF STRESS. Boresi, A. P.; Sidebottom, O. M. (Univ. of Illinois, Urbana). Nucl. Eng. Des.; 18: No. 3, 415-56(1972). (CONF-710903–29).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Information is presented which is concerned principally with the basis for the formulation of a creep model that represents data on metals sufficiently accurately and that lends itself to numerical analysis of creep under multiaxial states of stress. A phenomenological approach is taken. Several forms of relations and flow conditions for multiaxial creep are considered. Comparisons of analytical predictions with experimental results are shown. Recommendations for numerical analysis of creep in engineering machines and structures subject to multiaxial stress states are given, and a promising technique for collection of the voluminous data that result from numerical stress analysis is indicated. An extensive reference list is included. (auth)

31531 MEASUREMENTS OF THERMAL CONDUCTIVITY OF NUCLEAR MATERIALS. Chamero Ferrer, A.; Gispert Benach, M. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid); 16: No. 75, 19-26(Jan-Feb 1972). (In Spanish).

A technique for the measurement of thermal conductivity by a comparative method using cylindrical probes one centimeter in diameter was used. This diameter is considerably less than that described in the bibliography. The temperature increments obtained between the probes and the wall of the furnace imply only a lateral loss of 1 to 2% of the total heat flow. By means of this technique measurements of thermal conductivity up to 300°C were made in uranium metal and up to 400°C in dispersions of Al_2O_3–UAl_3 in a matrix of aluminum with satisfactory results. (tr-auth)

31532 CATHODE-VACUUM ETCHING OF URANIUM IN THE VUP-2K FACILITY. Skorov, D. M.; Dashkovskii, A. I.; Volkov, V. B.; Kalin, B. A. At. Energ. (USSR); 32: No. 4, 319-20(Apr 1972). (In Russian).

A vacuum discharge chamber was designed to operate at 10^{-4} mm pressure for the purpose of vacuum etching samples of uranium for electron microscope studies of their structures. A potential of 5.0 kV and a current of 1 to 3 mA with an etching time of 30 to 60 min are sufficient to elucidate the structure of materials like uranium metal. (K.S.W.)

31533 EFFECT OF TECHNOLOGICAL FACTORS ON THE CORROSION RESISTANCE AND MECHANICAL PROPERTIES OF NIOBIUM–TANTALUM ALLOYS. Dontsov, S. N. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 32: 152-60(1971). (In Russian).

Results are reported from studies on the effects of various technological factors on the corrosion resistance and mechanical properties of various Nb–Ta alloys. (Referativnyi Zh.)

31534 METALLOGRAPHIC STUDIES OF FATIGUE IN 20 PERCENT COLD-WORKED ZIRCALOY-2 CONTAINING ZIRCONIUM HYDRIDE. Wanhill, R. J. H.; Ryder, D. A.; Davies, T. J. (Univ. of Manchester, Eng.). J. Nucl. Mater.; 43: No. 2, 75-85(May 1972).

The fatigue behavior of unhydrided and hydrided 20% cold-worked Zircaloy-2 reactor pressure-vessel tubing was studied for fluctuating tension at room temperature and 300°C and for reversed torsion at room temperature. At room temperature, high concentrations of zirconium hydride markedly reduced the critical crack length. This effect was attributed to a lowering of the fracture toughness, since hydrides fracture in the path of crack propagation and promote matrix cleavage. At 300°C, hydride particles constrained by the matrix were plastically deformed without fracturing; the toughness was probably unaffected by the presence of hydride. (auth)

31535 ORDERING AND STACKING FAULTS IN Zr/10.0 AT. PERCENT Al. Tiwari, S. N.; Lloyd, D. L.; Tangri, K. (Univ. of Manitoba, Winnipeg). J. Nucl. Mater.; 43: No. 2, 207-9(May 1972).

X-ray and electron microscopy studies were made on a Zr–10.2 at. % Al alloy to investigate the possibility of short-range ordering. It was concluded that Zr is a high stacking fault energy material, and, on the basis of the results, it was not concluded as to whether the lowering of stacking fault energy was due to alloying or ordering or both. The extensive pile-ups developed as a result of the ordering gave greatly increased strength over the unalloyed material. The Vickers hardness for a 1 kg load increased from VPN 96 ± 3 for pure Zr to VPN 295 ± 5 for Zr–10.2 at. % Al. (P.C.H.)

31536 SEMICONDUCTOR METHOD FOR STUDYING THE EVAPORATION OF METAL ATOMS. Bol'shun, E. V.; Myasnikov, I. A ; Tabatadze, D. G. (Physical-Chemical Research Inst., Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 10, 1415-17(Oct 1971).

Translated from Zh. Fiz. Khim.; 45: No. 10, 2499-2503(Oct 1971).

The evaporation of metal atoms from various solid metal surfaces was studied with the help of semiconductor oxide films (ZnO, CdO, TiO_2) at low pressures of metal vapor (10^{-10} to 10^{-5} torr). The initial rate of change of the electric conductivity of the films, caused by the adsorption of atoms at the lowest possible surface coverages, is shown to be strictly proportional to the number of atoms striking the film in unit time, and therefore to the concentration of metal vapor to which the film is exposed. The measurements are used to determine the heats of evaporation of various metals (Na, Zn, Cd, Fe, Pb, W, Ti, Ag, Au, Pt, Ir) by Langmuir's and Knudsen's methods at low vapor pressures of the metal, and the results are compared with existing data. It is concluded that the semiconductor method of detection can be used for quantitative measurements of the rate of evaporation of various metals. (auth)

31537 THERMODYNAMICS OF LANTHANUM STANNIDE ($LaSn_3$) AND TIN–LANTHANUM ALLOYS. Matigorova, N. G.; Bayanov, A. P. (Metallurgical Inst., Novokuznetsk, USSR). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 10, 1384-5(Oct 1971).

Translated from Zh. Fiz. Khim.; 45: No. 10, 2440-2(Oct 1971).

The thermodynamic properties of homogeneous liquid lanthanum–tin alloys and the compound $LaSn_3$ (which is in equilibrium with the liquid) were investigated by an emf method at 773 to 973°K for lanthanum contents in the range 0.49 to 11.2 at. %. The activity coefficients, excess free energies, entropies, and enthalpies of lanthanum in the liquid alloys were calculated. The temperature variation of the free energy of formation of $LaSn_3$ from the elements was found. The results agree satisfactorily with the available calorimetric data. (auth)

31538 TRITIUM DIFFUSION IN 304- AND 316-STAINLESS STEELS IN THE TEMPERATURE RANGE 25 TO 222°C. Austin, J. H.; Elleman, T. S. (North Carolina State Univ., Raleigh). Contract AT(40-1)-3508. J. Nucl. Mater.; 43: No. 2, 119-25 (May 1972).

Tritium diffusion measurements in Types 304 and 316 stainless steel were carried out over the temperature range 25 to 222°C by direct measurement of tritium diffusion gradients. The $^6Li(n,\alpha)^3H$ reaction was used to inject tritium into the specimens and to produce initial tritium concentrations in the range 0.0005 to 0.007 ppM ^3H by weight. Three components were identified from the concentration profiles: a surface region approximately 5 μm thick where tritium trapping occurred, a normal diffusion profile which appeared characteristic of bulk diffusion, and a rapid diffusion "tail" which was tentatively attributed to grain boundary diffusion. Surface release measurements of tritium verified the existence of a surface trapping layer. The bulk diffusion component was consistent with classical diffusion solutions and gave: $D = 0.018 (+0.011 - 0.007) \times \exp - (0.61 \pm 0.01 \text{ eV}/kT)$ (cm^2/sec). The surface trapping was tentatively attributed to the presence of helium stabilized voids in the specimen surface layers. (auth)

31539 DIFFUSION OF Ni IN A Mg–0.5 PERCENT Zr ALLOY. Pegoud, J.; Guillaumin, J. (Societe Industrielle de Combustible Nucleaire, Veurey, France). J. Nucl. Mater.; 43: No. 2, 105-18 (May 1972). (In French).

At temperatures in the range 350 to 500°C, in a protective atmosphere, nickel diffused relatively fast into a Mg – 0.5% Zr alloy. The intrusion of nickel entailed the precipitation of zirconium in the form of nickel–zirconium compounds, while zirconium which was originally in the form of hydride remained in this form. The growth of the nickel–zirconium compounds along the [1120] direction of the matrix was sometimes accompanied by emission of dislocations. The increase of volume fraction of precipitates limited grain-growth and improved the creep resistance of the alloy at 500°C. The nickel–zirconium precipitates were stable in the presence of hydrogen: an anneal at high temperature in a hydrogen-rich atmosphere did not affect the structure and composition of previously formed precipitates. When all the zirconium had been fixed in the form of hydride, subsequent diffusion of nickel did not cause any further structural changes and the creep-behavior was not altered. (auth)

31540 INTERNAL FRICTION AND ELECTRON MICROSCOPE STUDIES OF STRAIN-AGEING IN ZIRCONIUM. Bedford, A. J.; Fuller, P. G.; Miller, D. R. (Univ. of Adelaide). J. Nucl. Mater.; 43: No. 2, 164-74(May 1972).

Internal friction experiments and transmission electron microscopy have been used to throw further light on the mechanism of strain aging which occurs at about 300°C in zirconium and zirconium–oxygen alloys. Internal friction specimens which have been heat-treated and deformed in a manner which leads to a discontinuous yield point in a tensile test show only logarithmic damping and the implication is that under these conditions the dislocations are strongly pinned. On the other hand in internal friction specimens treated in such a way that discontinuous yielding is not observed a transition from logarithmic to non-logarithmic damping takes place. Electron microscope studies of dislocation arrangements in sheet specimens given the same treatment as the internal friction wires have shown that the specimens which display a discontinuous yield point contain a well defined cellular structure of tangled dislocations. It is believed that with such a structure the dislocations are strongly pinned as a result of both solute atom locking and dislocation interactions. In specimens deformed under such conditions that no discontinuous yield point occurs, a more uniform array of dislocations is formed. Here the pinning of the dislocations is much weaker because the effects of both solute locking and interaction locking are reduced and, under these conditions, the stresses imposed on the specimen during the internal friction experiments are sufficient to cause unpinning to take place. Some observations on the variation of logarithmic damping with temperature are also reported. These have been interpreted as arising from sub-grain boundary relaxation effects. (auth)

31541 SODIUM–LEAD PHASE DIAGRAM. Hubberstey, P.; Pulham, R. J. (Univ. of Nottingham, Eng.). J. Chem. Soc., Dalton Trans.; No. 7, 819-21(1972).

The sodium–lead phase diagram was determined up to 7.8 atom % lead by thermal and resistance methods. A eutectic occurs at 0.10 atom % lead and 97.32°C. The partial molar enthalpy and entropy of solution of lead in liquid sodium is 7.07 kcal (29.6 kJ) g^{-1} atom and 5.52 cal (23.1 J) $°C^{-1}g^{-1}$ atom respectively. (auth)

31542 THEORY OF BURNING CURVE IGNITION OF NUCLEAR METALS. Musgrave, L. E. (Dow Chemical Co., Golden, Colo.). J. Nucl. Mater.; 43: No. 2, 155-63(May 1972).

A theory describing burning curve ignition of nuclear metals was developed. The nature of burning curve ignition allows a simple expression relating metal ignition temperature to specific surface area, oxidation rate, and mass of oxide on the surface. The theory, with extensions, explains most variables which influence ignition temperatures of nuclear metals. The theory shows good numerical agreement between predicted and experimentally determined ignition temperatures of uranium and plutonium, using oxidation rates determined at temperatures near the ignition temperatures. (auth)

31543 EFFECT OF STRAIN RATE AND TEMPERATURE ON THE YIELD AND FLOW OF POLYCRYSTALLINE NIOBIUM AND MOLYBDENUM. Briggs, T. L. (Univ. of Auckland, New Zealand); Campbell, J. D. Acta Met.; 20: No. 5, 711-24(May 1972).

Specimens of polycrystalline niobium and molybdenum were strained in compression at constant strain rates from 1.7×10^{-4}

to 10^2 sec^{-1} and at temperatures from 77 to 600°K. Both materials exhibited a definite yield point, though in niobium the yield drop became small at the lower temperatures. Results are presented showing the variation of the lower yield stress and the flow stress at 8% strain with strain rate and temperature and for molybdenum data are given concerning the stress at which twinning first occurred. The experimental data are discussed in relation to the theory of thermally activated flow and it is shown that the results cannot be described in terms of a single mechanism unless the apparent activation energy depends on temperature as well as stress. Several possible interpretations of this are examined, of which two are considered the most reasonable: first, an activation entropy that is stress and temperature dependent; secondly, a change from one rate-controlling mechanism to another as the temperature is increased. (auth)

31544 ULTRASONIC STUDY OF THE BETA → OMEGA PHASE TRANSFORMATION IN Zr–Nb ALLOYS. Goasdoue, C.; Ho, P. S.; Sass, S. L. (Cornell Univ., Ithaca, N. Y.). Acta Met.; 20: No. 5, 725-33(May 1972).

Elastic constant, ultrasonic attenuation, and x-ray measurements were made as a function of temperature on Zr–Nb single crystals in order to study the mechanism of the $\beta \rightarrow \omega$ phase transformation. In the Zr–20 wt% Nb alloy C_{44} decreased with decreasing temperature starting at 330 to 340°K reaching a minimum at 160°K, while both C′ and C_{11} showed a positive deviation from linear quasiharmonic behavior starting at 250 to 280°K. These observations are reversible with temperature. X-ray measurements indicated that little if any ω phase was present in the 20 wt% Nb alloy at 300°K and that upon cooling to 89°K a small amount of ω phase was formed. It is suggested that the positive deviation of C_{11} and C′ from the extrapolated values based on quasiharmonic theory is due to the presence of the ω phase and that the onset of the $\beta \rightarrow \omega$ transformation is indicated by the first sign of deviation from linearity. The negative deviation of C_{44} from quasiharmonic behavior is attributed to a softening of the bcc structure which is a precursor to the actual transformation. The observations on the Zr–25 wt% Nb alloy are in general agreement with these suggestions. In the Zr–30 wt% Nb alloy the x-ray results indicated that no ω phase is present over the temperature range 89 to 300°K and C_{11}, C′, and C_{44} all showed a normal linear variation with temperature, in agreement with the above suggestions. The internal friction peak observed at 100 to 120°K in the Zr–20 wt% Nb alloy was attributed to the lattice distortion associated with the $\beta \rightarrow \omega$ transformation. The higher temperature internal friction peak, which is present in the 25 and 30 wt% Nb alloys, but not in the 20 wt% Nb alloy, was attributed to a process occurring entirely in the β phase. (auth)

31545 ROLE OF GRAIN SIZE AND SHAPE IN STRENGTHENING OF DISPERSION HARDENED NICKEL ALLOYS. Wilcox, B. A.; Clauer, A. H. (Battelle Memorial Inst., Columbus, Ohio). Acta Met.; 20: No. 5, 743-57(May 1972).

Thermomechanical processing was used to develop various microstructures in Ni, Ni–2ThO_2, Ni–20Cr, Ni–20Cr–2ThO_2, Ni–20Cr–10W, and Ni–20Cr–10W–2ThO_2, and the influence of microstructure on room temperature and elevated temperature strength was investigated. The yield strength at 25°C increased with substructure refinement according to the Hall–Petch relation. It was found that substructure refinement was a much more potent means of strengthening at room temperature than was dispersion hardening. At elevated temperature (1093°C), the most important microstructural feature affecting strength of dispersion hardened nickel alloys was the grain aspect ratio, i.e., grain length, L, divided by grain width, l. The yield strength and creep strength increased linearly with increasing L/l and the following relation was obeyed: $\sigma = \sigma_e + K(L/l - 1)$, where σ_e = strength at L/l = 1 (equiaxed grains) and K = a constant, defined as the grain aspect ratio coefficient. The significance of this relation is discussed in terms of grain boundary sliding, which is a major mode of deformation at elevated temperatures. (auth)

31546 TERTIARY CREEP PROCESSES IN 20 PERCENT Cr, 25 PERCENT Ni AUSTENITIC STAINLESS STEELS OF DIFFERING Nb/C RATIOS. Adamson, J. M.; Martin, J. W. (Oxford Univ.). J. Iron Steel Inst. (London); 210: Part 4, 271-5(Apr 1972).

A study was made of six 20% Cr, 25% Ni austenitic stainless steels in which the proportion of Nb varied with two basic carbon levels (0.05 and 0.1 wt %) to give hypo-, hyper-, and stoichiometric compositions for the precipitation of all the carbon as NbC. Creep tests were performed in air at 750°C under constant load conditions, and the effects of stress, alloy composition, and structure were examined. At high stresses (i.e., above ~110 MN m^{-2}) the mode of fracture was transgranular, and at lower stresses failure it was by wedge crack growth. A comparison was made between specimens tested after solution treatment and specimens aged at 750°C before testing, and it is found that with increased aging time the creep life was reduced and the proportion of the total creep life spent in tertiary creep was increased. The results suggest that precipitation promotes the nucleation of cracks but impedes their propagation, and the roles of the carbides $M_{23}C_6$ and NbC in this context are discussed. (auth)

31547 DEFORMATION STRUCTURE OF MOLYBDENUM 34 PERCENT RHENIUM. Witcomb, M. J.; Dew-Hughes, D. (Univ. of Lancaster, Eng.). Acta Met.; 20: No. 6, 819-27(Jun 1972).

Polycrystalline molybdenum–34% (at.) rhenium was deformed by cold rolling. The variation in twin and dislocation microstructures produced by longitudinal, transverse, cross and pack rolling is reported. Deformation is initially accompanied by much twinning; twin formation being more difficult when the material is rolled in a direction transverse to the original rolling direction. A dislocation cell structure begins to form after about 10% deformation by single direction rolling, but forms at a lower deformation by rolling in two directions. Within limits, the dislocation cell size and wall thickness can be varied by the use of different rolling schedules. The structure of the pack rolled material is shown to be due to constraints imposed by the jacket. Failure of this material results from the growth of voids under an internal tension. (auth)

31548 FERRITIC Cr–Mo–STEEL WITH NIOBIUM ADDITION USABLE FOR THE CONSTRUCTION OF SODIUM-COOLED NUCLEAR REACTORS. Lorenz, K.; Kranz, E.; Fabritius, H. A. Mannesmann Forschungsber.; 78: No. 10, 3-7(1970). (In German).

The use of ferritic steels in combination with austenitic materials in sodium-cooled reactors requires inhibition of carbon transfer from the ferritic steel elements to the austenitic material. Systematic diffusion experiments using allied steels with niobium, titanium, and vanadium have demonstrated that the addition of niobium and titanium inhibits carbon transfer. On different steels alloyed with niobium the separated phases were isolated. Further experiments were carried out with steel containing completely stabilized niobium. The transition behavior and the mechanical properties were studied with respect to the heat-treatment. (INIS)

31549 LOW TEMPERATURE DEFORMATION IN Fe–Cr AND Fe–V ALLOYS. Karashima, Seiichi; Maruyama, Kouichi; Ono, Noboru (Tohoku Univ., Sendai). J. Jap. Inst. Metals; 36: No. 3, 218-23(Mar 1972). (In Japanese).

The yield strength of Fe–7% Cr alloy and Fe–3 to 7% V alloys was measured in the temperature range from 400 to 77°K. These alloys showed no appreciable alloy-softening, but stronger temperature dependence of yield strength than that of pure iron at temperatures lower than 150°K. In addition, alloying of chromium or vanadium lowered the critical temperatures and also the activation area for deformation. These behaviors were in contrast with those generally found in the alloys which show alloy-softening. The strong temperature dependence of yield strength in these alloys seemed to be associated with the strong interaction between the alloying elements and interstitial impurity atoms. (auth)

31550 DESIGN CRITERIA FOR THE BENDING FATIGUE STRENGTH AT 10^{12} CYCLES OF FILLET WELDED MILD STEEL PLATE SUBJECTED TO NARROW BAND RANDOM LOADING. pp 273-81 of Fatigue of Welded Structures. Vol. 2. Cambridge, Eng.: Welding Institute (1971).

Fatigue testing and evaluation of the fatigue behavior of mild steel fillet welded cruciform joints subjected to narrow band random loading were investigated under conditions relevant to nuclear power components. The results showed that the high cycle bending fatigue behavior was unaffected by frequency within the range 100 to 2500 Hz, by temperature within the range RT to 350°C, by size within the range 9.5 to 25 mm ($^3/_8$ to 1 in.) and by certain welding features. Design curves are presented for lives of up to 10^{12} cycles which are applicable to these ranges of conditions for toe ground welds. The fatigue strength was shown to be effected by mean stress and this was allowed for in the design curves. The recommended maximum cyclic root mean square stress for a life of 10^{12} cycles is within the range 7 to 10 N/mm^2 (1000 to 1500 lbf/in.^{2}) depending on the mean stress level. Unground welds were shown to give a lower fatigue strength than toe ground welds, whereas some gain in fatigue strength over the toe ground welds was shown to be possible by fully contouring the welds. (auth)

31551 FIZIKO-KHIMIYA REDKIKH METALLOV. K60-LETIYU SO DNYA ROZHDENIYA CHLENA-KORRESPONDENTA AN SSR E. M. SAVITSKOGO. (Physicochemistry of Rare Metals. On the Event of the 60th Birthday of Academician E. M. Savitskii). Tananaev, I. V. (ed.). Moscow; Izdatel'stvo Nauka (1972). 228p.

The 26 papers included contain information on the structure and physical properties of monocrystals of refractory and rare earth elements and over 200 phase diagrams involving alloys of W, Mo, Re, Nb, V, Y, Sc, La, Ce, Gd, Sm, and the noble metals Pd, Ru, and Os. Special consideration is given to certain features of alloys and compounds such as superconductivity, thermoemission, magnetism, high resistance, and high elasticity. Electrical resistance computations for metal systems were made based on quantum physics. (tr-auth)

31552 SHOCK VISCOSITY AND BRITTLENESS THRESHOLD OF MOLYBDENUM. Gulyaev, A. P.; Morgunova, N.N.; Malkhasyan, N. M. Probl. Prochnosti; No. 8, 70-3(Aug 1971). (In Russian).

The characteristics of the breakdown of molybdenum and the effects of geometric factors on this process were studied. It was noted that in addition to internal factors such as composition and structure, the brittleness threshold may also depend on external factors such as the cross section of the sample and the sharpness of a cut, and that there has been insufficient data characterizing the effect of external factors. The object of the study was the alloy TzM-2A (Zr-0.1%, Ti-0.13%, C-0.0037%, and the remainder Mo) in the shape of a bar of diameter 16 mm. The tests were conducted on metal deformed by rolling at 1200°C with a degree of deformation of 70% and recrystallized at an annealing temperature after deformation of 1500°C for 1 h. Samples of cross section 10 × 10 mm were made from the rod with a cut of depth 2 mm and radii 1.0, 0.5, 0.25 and 0.1 mm. The brittleness threshold as determined on the basis of the shock viscosity for recrystallized molybdenum was higher than deformed molybdenum (400 to 480 and 100 to 220°C, respectively). An increase in the sharpness of the cut did not change the temperature for the transition of molybdenum into the brittle state. Breakdowns occurred across the sample in deformed molybdenum in the brittle state but in the transition temperature region a portion of the samples began to tear and another portion was bent. The fraction of the bent portion of the sample increased with an increase in temperature. The sharpness of the cut did not affect the relationship of the bent and broken parts of the cross section. The specific work expended on breakdown of wires was determined, and it decreased with a drop in temperature and became close to zero at the lower brittleness threshold. (JPRS)

31553 ANALYSIS OF THE SHEAR STRESS DISTRIBUTION IN VARIOUS SLIP SYSTEMS OF TORSIONALLY STRESSED SINGLE CRYSTALS OF CADMIUM. Ruehlicke, D. (Bergakademie, Freiberg i. B.). Phys. Status Solidi (a); 10: No. 1, 99-106(16 Mar 1972).

An analysis of the shear stress distribution in basal slip systems and pyramidal slip systems of second type and second order was made for a deformation by torsion of cadmium single crystals. The calculations show that basal slip is the prevailing deformation mechanism at torsion. The results may be generalized to other hcp metals with axial ratio larger than ideal. (auth)

31554 ANISOTROPY IN GREEN COMPACTS. Roman, O. V.; Mukunda, P. G. (Indian Inst. of Tech., Kharagpur). pp 73-87 of Proceedings of the Symposium on Powders and Sintered Products. Bombay; Dept. of Atomic Energy (1971).

From Symposium on powders and sintered products; Kanpur, India (31 Jan 1971). See CONF-710118.

Die-pressed green compacts exhibit large anisotropies in the green strength and electric conductivity. Shrinkages during sintering are also anisotropic. There seems to be no systematic work to evaluate the factors controlling anisotropy and the possible causes for it. Spherical, atomized, electrolytic, and reduced powders were investigated. Anisotropies in copper, iron, lead, tin, and tungsten were studied at different densities. Electric conductivity and strength properties were measured to obtain a clear insight into the causes of anisotropy. (auth)

Radiation Effects

Refer also to abstracts 30666, 31432, 31606, 32288, 32752, 32756, and 32791.

31555 (CONF-720420-4) EFFECT OF NEUTRON IRRADIATION ON THE DUCTILITY OF AUSTENITIC STAINLESS STEEL. Bloom, E. E.; Weir, J. R. Jr. (Oak Ridge National Lab., Tenn.). [1971]. 25p. Dep. NTIS.

From Conference on reactor materials performance; Richland, WA. (24 Apr 1972).

The effects of fast neutron irradiation on the tensile and creep-rupture ductility of austenitic stainless steels are presented. At low temperatures, below 450°C, radiation causes a reduction in the strain hardening exponent and thus the uniform strain. At high temperatures (above 750°C) reduced ductility results from helium embrittlement. At intermediate temperatures, hardening and helium effects act synergistically to produce lower ductility than would result from either effect alone. Possible mechanisms responsible for the observed changes are discussed. (auth)

31556 (COO-1799-7) SPECIFIC HEAT STUDY OF HELIUM-BUBBLE FORMATION IN ALPHA-IRRADIATED ALUMINUM. Katyal, O. P.; Keesom, P. H.; Cost, J. R. (Purdue Univ., Lafayette, Ind.). [1970]. 13p. (CONF-710601-17). Dep. NTIS.

From International conference on radiation-induced voids in metals; Albany, N. Y. (9 Jun 1971).

The low-temperature specific heat of Al was measured after annealing treatments following cyclotron irradiation to produce a concentration of about 50 and 300 ppM helium. For specimens annealed above 600°C, the presence of the characteristic helium lambda peak at 2.15°K provides definite evidence for the precipitation of helium as gas bubbles. Examination of the magnitude of the lambda peak indicates that helium precipitation is complete after ten hours at 625°C. The presence of helium bubbles observed by electron microscopy in specimens which with the same anneal did not produce the lambda peak is shown. This is interpreted in terms of a critical bubble size and thus a critical number of monolayers required for helium to show the lambda transition in aluminum. (auth)

31557 (HEDL-TME-71-66) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, February-April 1971. Claudson, T. T. (ed.) (Hanford Engineering Development Lab., Richland, Wash.). May 1971. Contract AT(45-1)-2170. 370p. Dep. NTIS.

Research on irradiation of refractory reactor materials is reported. Programs conducted by Atomics International, ANL, BMI, GE, HEDL, Idaho Nuclear Corp., ORNL, and PNL are described. (J.R.D.)

31558 (HEDL-TME-71-161) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, August-October 1971. (Hanford Engineering Development Lab., Richland, Wash.). 1971. Contract AT(45-1)-2170. 290p. Dep. NTIS.

Research on irradiation of refractory reactor materials is reported. Programs conducted by Atomics International, Aerojet Nuclear, ANL, BMI, GE, Gulf Atomic, HEDL, NRL, PNL, University of Cincinnati, and Westinghouse are described. (J.R.D.)

31559 (IS-2773) MECHANICAL PROPERTIES AND DEFECTS IN REFRACTORY METALS. Wechsler, Monroe S. (Ames Lab., Iowa). [1972]. 46p. (CONF-710905-5). Dep. NTIS.

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971).

A rapporteur summary of the contributions to the session, including a brief general survey of the topics under discussion, is presented. The first topic was the temperature dependence of yielding and flow in the body-centered cubic (bcc) metals. The controversy between intrinsic and extrinsic mechanisms for the low-temperature strength of bcc metals is reviewed, with particular emphasis on the phenomenon of alloy softening. The experimental evidence for alloy softening in niobium and tantalum alloys is described. Two intrinsic mechanisms (double kink nucleation and sessile-glissile transformations) and one extrinsic mechanism (interstitial impurity hardening) are discussed. Experimental results are cited illustrating the influence of interstitial impurities on the temperature dependence of the yield stress. Despite this impurity effect, a significant amount of temperature dependence is found that is difficult to attribute to impurities. Hence, it appears that neither intrinsic nor extrinsic mechanisms can be ruled out at present, and a resolution of the controversy must await further research results. Next, the effect of radiation on the temperature dependence of yielding in the bcc metals is reviewed. There appears to be clear evidence that the temperature dependence is increased on irradiation (for example, in high-purity W and Nb). The effect is apparently not as pronounced in less pure samples, however, and possible reasons for this are discussed. The influence of impurities on radiation hardening in the bcc metals is discussed in terms of radiation-anneal hardening (RAH). In this phenomenon, an additional increase in yield stress is observed on post-irradiation annealing at moderate temperatures (about 100 to 250°C). Earlier interpretations of RAH involved the motion of intrinsic point defects (vacancies or self interstitial atoms). However, for group V refractory metals V and Nb, comparison with annealing studies using electrical resistivity and internal friction measurements indicates that RAH is due to the migration of interstitial impurities. (108 references) (auth)

31560 ANALYSIS OF RADIATION-INDUCED EMBRITTLEMENT GRADIENTS ON FRACTURE CHARACTERISTICS OF THICK-WALLED PRESSURE VESSEL STEELS. Loss, F. J.; Hawthorne, J. R.; Serpan, C. Z. Jr; Puzak, P. P. (Naval Research Lab., Washington, D. C.). J. Eng. Ind.; 93: No. 4, 1007-15(Nov 1971).

The fracture behavior of thick-walled nuclear vessels is considered for the case of a radiation-induced toughness gradient through the wall which characteristically results from neutron attenuation by the wall material itself. Fracture-safe design analyses based on linear elastic formulations or extrapolations of these formulations to the elastic-plastic regime are not sufficiently developed to characterize the integrated behavior of a wall whose toughness can range from brittle at the inner surface to highly ductile at the outer surface. Solutions to the problem in the foreseeable future will be obtained only by experimental means. The present approach uses the Fracture Analysis Diagram (FAD) together with a new interpretative method for fracture extension resistance based on modified dynamic tear specimens as the tools for gradient assessments. With these techniques the significance of the toughness gradient through the wall is assessed in terms of thick section mechanical constraint, and fracture characteristics of the complete wall are predicted. Characterization of a hypothetical 8-in. vessel wall is based on measured through-thickness fluence levels; this behavior is correlated with fracture toughness degradation for steels of varying sensitivity to irradiation using the FAD. Results indicate that major portions of the vessel wall remain above the Fracture Transition-Elastic (FTE) temperature, which dictates yield stress loading requirements for fracture, when the wall temperature is maintained at the limiting value, NDT + 60°F, for the inside surface as suggested by current AEC criteria. Fracture extension resistance measurements based on data from a 3-in. thick plate having a metallurgically induced toughness gradient suggest that nuclear vessels with analogous gradients will not fracture in an unstable fashion and will not generate missiles capable of breaching the containment system. Additional research is necessary to fully develop the approach for application to the individual reactor vessel. (auth)

31561 EFFECT OF ELECTRON IRRADIATION ON DIFFUSION IN GOLD–SILVER ALLOYS. Spreng, D. T.; Hilliard, J. E.; Kauffman, J. W. (Northwestern Univ., Evanston, Ill.). J. Appl. Phys.; 43: No. 5, 2040-7(May 1972).

The effect of electron irradiation on diffusion in gold–silver alloys at −196°C was determined from the decrease in amplitude of short wavelength (11 to 20 Å) composition modulations produced by vapor deposition. Mixing occurred during irradiation. For an electron current of 2 μA cm^{-2} at 2 MeV the effective interdiffusivity was approximately 1×10^{-22} cm^{2}sec^{-1}. The interdiffusivity was directly proportional to the electron current and increased with increasing electron energy. During warm-up to room temperature after irradiation a single stage of mixing was observed above −70°C. The mixing during irradiation is attributed to the migration of interstitialcies to sinks and that during warm-up to the migration of vacancies to sinks. These results support the hypothesis that annealing stages around 0°C in pure fcc metals are due to vacancy migration. (auth)

31562 IN-REACTOR CREEP OF HELIUM-PRESSURIZED 304L STAINLESS STEEL TUBE. Walters, L. C.; Walter, C. M.; Pugacz, M. A. (Argonne National Lab., Idaho Falls, Idaho). J. Nucl. Mater.; 43: No. 2, 133-42(May 1972).

In-reactor creep experiments were carried out on helium-pressurized Type 304L stainless steel tubing. The creep capsules were irradiated in row 7 of the EBR-II fast breeder reactor at an irradiation temperature of about 380°C. The hoop stress on the capsules ranged from 0 to 27.3 ksi. To date, the capsules have been irradiated to a fast fluence (>0.1 MeV) of 1.4×10^{22} n/cm^2 with a peak fast flux (>0.1 MeV) of 1×10^{15} n/cm$^2 \cdot$ sec. A steady-state creep region was found in the fluence range of around $3 \times 10^{21} \rightarrow 1.4 \times 10^{22}$ n/cm^2 (>0.1 MeV). In the steady-state region the creep rate was found to be linearly related to the hoop stress. (auth)

31563 ORDERING PROPERTIES AND INTERPRETATION OF RADIATION DAMAGE IN Au–15 AT. PERCENT Ag ALLOYS. Giardina, M. D. (EURATOM–CCR, Ispra, Italy); Schuele, W.; Frank, W.; Seeger, A. Radiat. Eff.; 12: No. 3-4, 277-80(Feb 1972).

The equilibrium value of the electrical resistivity of Au–16.25 at. % Ag was determined as a function of temperature. In addition, isochronal annealing of quenched Au–15 at. % Ag alloys was studied by means of resistivity measurements. Both types of experiments indicate that in these alloys a decrease of the degree of order gives rise to an increase of the electrical resistivity. This result confirms the previous interpretation of the radiation damage and its recovery in low-temperature electron-irradiated Au–15 at. % Ag alloys in terms of the two-interstitial model. (auth)

31564 INFLUENCE OF γ RADIATION OF ^{60}Co ON THE ADHESION OF POLYETHYLENE TO STEEL. Belyi, V. A.; Pleskachevskii, Yu. M.; Pavlyuk, T. G. Dokl. Akad. Nauk BSSR; 15: No. 10, 903-6(Oct 1971). (In Russian).

The effects of gamma radiation from ^{60}Co on the adhesion property of high-density polyethylene to steel were studied. Empirical formulas are given with which the stability of the adhesion bond can be calculated for a radiation dose of 0.1 to 10 mRad, and for a temperature range of 410 to 515°K. Increase of dose to the polymer in air was equivalent to an increase in the temperature of formation of the compound. (tr-auth)

31565 CONSEQUENCES OF THE SWELLING OF STRUCTURAL MATERIALS ON THE DESIGN OF FAST REACTORS. Class, G.; Hoang, Y. S.; Hitzschke, U.; Kleefeldt, K. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Eng. Des.; 18: No. 2, 335-52(1972). (In German). (CONF-710903–25).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

The concept of "radial core constraint" is described in the light of a survey of the changes in structural materials expected in a high fast-neutron flux environment together with the attendant problems arising for sodium-cooled fast breeder reactors. This formulation results in the construction concept of "plane of radial constraint" whose characteristics are outlined. As a result of these ideas, reactor-core design criteria are deduced for the core constraint principle. Simplifications and assumptions for design and optimization calculations are briefly explained and the most important results are indicated. This is followed by suggestions for the design and construction of the core restraint. Because of radiation induced swelling and creeping of structural materials, no supporting structures must be located in the region of high neutron fluxes. This, together with the primary requirement of negative reactivity coefficients of thermal fuel element bowing and following the required minimization of stresses on materials, results in the establishment of two planes of radial core constraint above the reactor core proper. It is suggested that the fuel element boxes should be reinforced against transverse pressure loads in the planes of radial constraint and should be made flexible against pressure loads acting from all sides. The decisive influence of the very high friction coefficients in sodium will be removed changing to rolling friction. These measures make the planes of radial constraint calculable. Moreover, low-pressure hydraulic elements (sodium) can be used for outer core restraint which, just as the fuel elements proper, can be exchanged. (auth)

31566 CLADDING-STRENGTH ANALYSIS UNDER THE COMBINED EFFECT OF CREEP AND PLASTICITY IN FAST-REACTOR ENVIRONMENTS. Guyette, M. (Belgonucleaire, Brussels). Nucl. Eng. Des.; 18: No. 1, 53-68(1972). (CONF-710903–13).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

A description is made of the computer program CRASH which is used in the calculation of three-dimensional stresses and strains in fuel-cladding tubes under creep and/or plasticity. Input data are easily introduced in the program by means of a flexible method which enables a realistic representation of the complex loading conditions of the claddings. In particular, power and temperature cycling can be readily taken into account. Tentative cladding-strength criteria based on the cumulative damage concept are given. Typical results of calculations relative to the ratchetting of a can under combined creep and plasticity are also given. These results show, in particular, the marked influence of the steel swelling phenomenon. Their analysis points quite clearly to the present lack of reliable data on the properties of materials irradiated in fast-reactor environments. (auth)

31567 CHANGES IN THE DENSITY OF MONOCRYSTALLINE TUNGSTEN DURING NEUTRON BOMBARDMENT. Bykov, V. N.; Birzhevoi, G. A.; Zakharova, M. I. At. Energ. (USSR); 32: No. 4, 323-4(Apr 1972). (In Russian).

Monocrystalline samples of tungsten were produced by electron beam zone melting, and were irradiated at 450 to 500°C in hermetically sealed ampules with an integral flux of 1.4×10^{22} n/cm^2. Subsequent annealing of the samples at temperatures ranging from 500 to 2,200°C was conducted. A decrease in density of 1.17% resulted from irradiation, and annealing partially restored the original density: after treatment at 2,200° the final density differed from the original by only 0.12%. (K.S.W.)

31568 EMPIRICAL REPRESENTATION OF IRRADIATION-INDUCED SWELLING OF SOLUTION TREATED TYPE 304 STAINLESS STEEL. Bates, J. F.; Straalsund, J. L. (Westinghouse Hanford Co., Richland, Wash.). Nucl. Technol.; 14: No. 3, 292-8 (Jun 1972).

Extensive data for irradiation-induced swelling in annealed AISI Type 304 stainless steel have been compiled. The following empirical equation is derived, and describes swelling as a function of irradiation temperature and fluence: $\%(\Delta V/V_0) = A(\phi t)^m + B$ where $m = 0.872 + 2.98 \times 10^{-3}$ T, $A = 2.65 \times 10^{-8}(\alpha^3) - 1.54 \times 10^{-5}(\alpha^2) + 2.24 \times 10^{-3}(\alpha)$, $\alpha = T - 348$, $B = 0.2[1 - e^{(-1.12\phi t)}]/[1 + e^{0.1(T-480)}]$, $\%(\Delta V/V_0) = \%$ change in volume, $\phi t = n/cm^2$ ($E > 0.1$ MeV) units of 1×10^{22} n/cm^2, and T = Temperature, °C. (auth)

31569 APPLICATION OF ELECTRON MICROSCOPY TO RADIATION DAMAGE STUDIES. Makin, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 388-461 of Electron Microscopy in Material Science. /Valdre, U. (ed.). New York; Academic Press, Inc. (1971).

From International school of electron microscopy; Erice, Italy (4 Apr 1970).

The damage process, the nature of the damage, and radiation damage studies in high-voltage microscopes are discussed. How atoms can be displaced from their normal sites by irradiation with energetic particles and how the concentration of point defects produced can be estimated are described. Interpretation of some important radiation damage effects is discussed. (129 references) (M.C.G.)

31570 FORM OF THE DEFECT CLUSTERS PRODUCED IN COPPER BY Cu$^+$ ION IRRADIATION. Wilson, M. M.; Hirsch, P. B. (Oxford Univ.). Phil. Mag.; 25: No. 4, 983-91(Apr 1972).

A detailed electron microscope study was made of the damage produced in copper by Cu$^+$ ions. 30 keV and 90 keV Cu$^+$ ions give rise to point defect clusters having a structure based on the vacancy type Frank sessile loop with Burgers vectors $a/3\langle 111\rangle$; there is evidence that parts of the circumference of many loops are dissociated into stair-rod dislocations and Shockley partials according to a mechanism proposed by Silcox and Hirsch (1959). This dissociation gives rise to areas of stacking fault on $\{111\}$ planes other than that of the loop plane, and in the case of a triangular loop can produce a stacking-fault tetrahedron, though such defects were not observed in Cu$^+$ ion damaged copper. (auth)

31571 DEFECTS OBTAINED BY Al$^+$ ION BOMBARDMENT OF POLYCRYSTALLINE ALUMINIUM SAMPLES. Ruault, M. O.; Jouffrey, B.; Joyes, P. (Faculte des Sciences, Orsay, France). Phil. Mag.; 25: No. 4, 833-51(Apr 1972). (In French).

Polycrystalline samples of aluminum were bombarded with 30 keV aluminum ions. The depth distribution of visible defects was obtained by means of electron stereo-microscopy and compared with that given by a model due to Sigmund and Sanders (1967). The nature of the defects was determined. Contrast studies as a function of the position of the defects and the thickness of the foil were developed. (auth)

Other Materials

Refer also to abstracts 30789, 30814, 30955, 30956, 31392, 31564, 32630, and 32751.

31572 (CONF-701105) PROCEEDINGS OF THE CONFERENCE ON CONTINUUM ASPECTS OF GRAPHITE DESIGN, GATLINBURG, TENNESSEE, NOVEMBER 9-12, 1970. Greenstreet, W. L.; Battle, G. C. Jr. (eds.) (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 759p. Dep. NTIS.

Forty-nine papers are included on the design and structural analysis of graphite components. A separate abstract was prepared for 41 papers. One paper was previously abstracted for NSA and may be located under Y-DA-3953 in the Report Number Index. (H.D.R.)

For abstracts of individual papers see: 30955, 30956, 31392, 31573-31605, and 32915-32919.

31573 (CONF-701105-, pp 3-12) CORRELATION OF PROPERTIES OF MANUFACTURED GRAPHITES. Armstrong, Philip E. (Los Alamos Scientific Lab., N. Mex.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

An homologous series of isotropic graphites was studied, and the effects of porosity on elastic moduli, thermal conductivity, and electric conductivity were evaluated. The graphites were Poco Company grades that were heated to 2900°C after sample fabrication. An approach which considered that the first 4 percent porosity was of a different type from the bulk porosity was found to provide a reasonable explanation of the data. Measurements of modulus and strength of a second series of isotropic graphites prepared from Santa Maria flours were found to be compatible with the results obtained on the Poco series. (auth)

31574 (CONF-701105-, pp 13-[illegible]) MECHANICAL AND THERMAL PROPERTIES OF AIRCO SPEER GRADES FOR NUCLEAR AND AEROSPACE APPLICATIONS. Simbeck, Leo F. (Air Reduction Co., Inc., New York). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

Manufactured graphite is a standard material of construction for nuclear and aerospace applications. Its increased strength with temperature coupled with refractoriness and light weight make it suitable for aerospace applications. The principal raw material for manufactured graphite is petroleum coke. Graphite can be manufactured from cokes from various type petroleum feedstock streams which not only impart particular physical, mechanical, and thermal properties but which also vary its nuclear properties. Further, graphite can be manufactured with different degrees of purity permitting its use as a nuclear moderator or shield. The principal mechanical and thermal properties of manufactured graphite are highlighted, and the range of properties obtainable commercially are discussed. (auth)

31575 (CONF-701105-, pp 25-39) MECHANICAL BEHAVIOR OF ARTIFICIAL GRAPHITES AS PORTRAYED BY UNIAXIAL TESTS. Greenstreet, W. L.; Smith, J. E.; Yahr, G. T.; Valachovic, R. S. (Oak Ridge National Lab., Tenn.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

Stress-strain behaviors which are representative of nuclear-grade, or equivalent, graphites are described and discussed. Since cyclic loading test results provide important insight into the characteristics of graphite behavior, emphasis is placed on results of this type. Monotonic loading curves are also considered, and both stress versus longitudinal strain and stress versus lateral strain curves are given for monotonic and cyclic loading. The new results given are combined with results published in the literature to provide a unified description of the observed behavior. (auth)

31576 (CONF-701105-, pp 40-9) MECHANICAL AND THERMAL PROPERTIES OF GLASS-LIKE CARBONS. Bradshaw, W. G. (Lockheed Missiles and Space Co., Palo Alto, Calif. Lockheed Palo Alto Research Lab.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

The properties of glass-like carbon can be varied to meet specific design requirements, either by varying the precursor materials or by the use of additives. Formulations which promote structure defects such as cross-linking and intercrystalline bonding result in an increase in mechanical strength. Utilizing this approach, the tensile strength has been increased from 17,000 to 29,000 psi and the compressive strength from 128,000 to 200,000 psi. The use of heat-treatment conditions which promote increasing crystalline order results in a slight decrease in strength. The use of graphite filler additions promote crystalline growth and rearrangement. The resultant product is a fine grain isotropic graphite in a glassy carbon matrix. The use of such additions result in a decrease in tensile strength but an improvement in the strain-to-failure. The thermal conductivity is greatly increased, resulting in improved thermal shock characteristics. Thus, it is possible to alter the characteristics of this class of materials to meet specific design requirements. (auth)

31577 (CONF-701105-, pp 50-9) DYNAMIC BIAXIAL AND ELEVATED-TEMPERATURE PROPERTIES OF ATJ-S GRAPHITE. Babcock, S. G.; Green, S. J.; Hochstein, P. A.; Gum, J. A. (General Motors Corp., Detroit, Mich.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

Descriptions are given of the techniques of and results from tests on ATJ-S graphite in which the fracture surface in biaxial stress and the fracture stress at various temperatures and heating rates were determined. The technique developed to load tubular specimens to fracture in four stress-ratio quadrants involves applying an axial load and a circumferential pressure simultaneously at controlled strain rates up to approximately 10/s. To study the high-heating-rate high-temperature properties, tensile specimens are heated by direct current at various rates up to 1000°F/s and then pulled to fracture at strain rates up to about 10/s. Results from the biaxial experiments showed that graphite follows a Mohr (internal friction theory) fracture criterion, where the critical shear stress at yield (or fracture in this case) is a function of the normal compressive stresses acting on the slip planes. Premature buckling caused by difficulties with the experimental technique in the compression-compression quadrant prevented obtaining valid data. Material scatter overshadows any strain rate sensitivity of combined-loading fracture stresses for strain rates from 10^{-3} to 10/s. Results showed that this material is unable to withstand any principal tensile strains in excess of about 1 to 1.5% strain, regardless of the loading state. Results from the high-heating-rate tests showed that no significant heating-rate or time-at-temperature effects on fracture stress were encountered up to near 5500°F. Above this temperature, time effects appeared important. Surface effects at temperatures near 6000°F caused localized porosity or pitting, thus reducing the true cross section of the test specimen. Interpretation of stress under these conditions from axial load measurement was difficult. (auth)

31578 (CONF-701105–, pp 60-85) MATERIAL-DESIGN CONCEPTS FOR FILAMENT-WOUND GRAPHITE–GRAPHITE HEATSHIELDS. Guess, T. R.; Bert, C. W. (Sandia Labs., Albuquerque, N. Mex.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

Three material-design concepts that may permit a filament-wound graphite-graphite composite (graphite fiber/graphite matrix) heatshield to achieve improved performance during reentry were evaluated. One concept is the use of a constant helical wrap angle, another is the use of the so-called quasi-isotropic wrap, and the final concept is the use of low pressures during the CVD (chemical vapor deposition) process of depositing the matrix. The pressure may be held constant, or it may be varied during the deposition process to achieve property gradients through the shell thickness. To evaluate the proposed design concepts, calculations were carried out to determine the ratios of the maximum thermal stresses induced by reentry heating to the strength of the composite material. The analysis used laminated orthotropic shell theory and experimentally measured material properties. The calculations showed that only the last concept mentioned results in a better safety margin than the currently used balanced helical ($\pm\Theta$) wrap CVD'd at atmospheric pressure. (auth)

31579 (CONF-701105–, pp 86-97) MICROSTRUCTURAL EVALUATION OF GRAPHITES FOR THEIR EROSION AND ABLATION CHARACTERISTICS IN AEROSPACE APPLICATIONS. Meyer, R. A.; Kratsch, K. M.; Dirling, R. B. Jr. (McDonnell Douglas Astronautics Co., La Jolla, Calif.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

A program has been undertaken to characterize the microstructures of graphites and their potential susceptibility to erosion and ablation. The pore structure of the graphites is considered to be a primary factor in determining the mass loss of carbon. Therefore, a combination of tests has been used to define the pore structure and those factors that influence it. These tests include optical microscopy for grain and macropore size determination; scanning electron microscopy for microporosity and binder/filler distribution; and gas permeability, helium density, and surface area determinations for apparent pore size distribution. Different types of graphites have been subjected to short-term oxidation and sublimation as a preliminary base toward obtaining a better understanding of the influence of microstructure. Nine types of graphites were selected, with different grain sizes, pore distributions, and types of fillers and binders, to determine the effect of the test conditions. This combination of tests has revealed several trends in the microstructure that appear to be influential. The pore structure is composed of both micropores and macropores. The micropores are a result of the usual shrinkage caused during pyrolysis of the binder phase; the macropores are formed by the packing of the grain or flour. A second factor in determining the macroporosity appears to be the agglomeration of filler and binder into high-density regions 75 to 250 microns in diameter. These are surrounded by lower-density regions which appear as high-gas-permeability zones that may have an influence on the microstructure ablation effects just below the surface of the graphite. The effect of these structures is discussed in detail. (auth)

31580 (CONF-701105–, pp 98-114) CHARACTERIZATION OF PRODUCTION-GRADE H-327 GRAPHITE FOR HTGR DESIGN. Cobb, H. R. W.; Engle, G. B.; Parry, S. J. S. (Gulf General Atomic, Inc., San Diego, Calif.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

The moderator graphite in High-Temperature Gas-Cooled Reactors (HTGRs) is also a containment and structural member of the core. The current core design uses an electrode-type anisotropic production-grade graphite, and the variations in the product that may occur in the production of the required kiloton quantities for HTGRs need to be well established. Knowledge of the behavior of the graphite with respect to mechanical strength, density, permeability, and chemical and thermophysical properties before and after nuclear irradiation is required to permit predictions as to the design and operating performance. A Great Lakes Carbon Company (GLCC) grade H-327 needle-coke graphite has been selected as the fuel and reflector block material for the Fort St. Vrain HTGR. Measurements of mechanical strength and its variations throughout the graphite log have been made on a portion of the logs produced to date and are correlated with production inspection tests. The strength (at room temperature) in the weakest section of an extruded log gave a safety factor of 3 over stresses resulting from the most pessimistic design assumptions. The strength was increased as a result of irradiation and at Fort St. Vrain median fluence levels ($\sim 5 \times 10^{21}$ n/cm^2, $E > 0.18$ MeV), the minimum increase in strength was 20%. The improvement in strength due to irradiation, together with changes in thermophysical properties and dimensions within a Fort St. Vrain fuel block, has been established in a series of capsule irradiations, at fluences beyond the maximum Fort St. Vrain fast neutron fluence of 8×10^{21} n/cm^2 ($E > 0.18$ MeV) at temperatures up to and beyond the Fort St. Vrain maximum of 1150°C. It was found that the rate of change in linear dimensions of H-327 graphite was similar to that of other needle-coke graphites at any given temperature, with slightly greater contraction being experienced before the onset of expansion. These tests also confirmed the expected reductions in thermal conductivity of up to ~50% and only slight variation in the coefficient of thermal expansion in the Fort St. Vrain core graphite at the end of life. These studies have led to a good understanding of the properties and irradiation behavior of H-327 graphite and have shown that it will meet the performance requirements of the Fort St. Vrain HTGR. (auth)

31581 (CONF-701105–, pp 115-36) CHARACTERIZATION OF SEVERAL TYPICAL POLYGRAPHITES WITH SOME CONVERGENCE ON SOLID BILLET ATJ-S. Pears, C. D. (Southern Research Inst., Birmingham, Ala.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

Several typical fine, medium, and relatively coarse grain graphites are characterized in terms of thermal and mechanical properties, variations in property, correlations of these properties with porosities and other monitors, and their typical flaws and inspectability. These graphites include nominal AXM-5Q, AXF-5Q, ATJ, G90, and solid billet ATJ-S. The need to characterize the material for a specific application is emphasized. Essentially, the argument is that proper characterization involves, first, the determination of the general property levels for a generic type, then a more intensive look at the critical properties involved in an application, and finally a screening of the uniformity and reproducibility that can be expected. A record of macrostructure and of inspectability by nondestructive test methods must be kept for each specimen, with the record of its properties. Such records enable judgments to be made on the properties of subsequently received large pieces that cannot be destructively tested and from which specimens for extensive testing cannot be cut. Judgments on the properties of such large pieces can be made by comparison of their macrostructure, the results of nondestructive tests, and a few property tests on specimens from selected locations where property "profiles" are known. The data and observations also should provide interest for those people who are designing hardware or parameter studies for biaxial tests, temperature stress tests, fracture mechanics tests, or impulse loading. (auth)

31582 (CONF-701105–, pp 137-54) MICROSTRUCTURAL ANALYSIS TO DETERMINE ELASTIC MATERIAL PROPERTIES OF A FILAMENT WOUND GRAPHITE COMPOSITE HAVING ORTHOTROPIC CONSTITUENTS. Biffle, J. H. (Sandia Labs., Albuquerque, N. Mex.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

A microstructural analysis was made of a filamentary composite which consisted of a transversely isotropic fiber and a cylindrically transversely isotropic matrix. The properties of the matrix were varied from isotropic to anisotropic conditions while holding the fiber properties constant. Then the matrix properties were held constant, and different fibers were used. Longitudinal and transverse direction composite moduli and the associated Poisson's ratios were calculated. The stress distribution throughout the composite due to transverse loading and a stress concentration factor were calculated. A two-dimensional finite element computer program was used to solve the problem. (auth)

31583 (CONF-701105–, pp 222-46) STRESS-STRAIN PROPERTIES OF GRADE ATJ GRAPHITE UNDER COMBINED STRESSES. Weng, Tu-Lung (Union Carbide Corp., Parma, Ohio. Carbon Products Div.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

A generalized stress-strain relation for a transversely isotropic, nonlinear material has been derived by using deformation theory of plasticity. It was assumed that the material anisotropy does not change with deformation and that the degree of nonlinearity is independent of orientation and can be described by a single-valued function of the stress state. Combined stress tests were conducted on Grade ATJ graphite cylindrical specimens by subjecting them to combinations of internal, external, and axial pressures. In most tests, the stress ratio was maintained constant and the loads were increased monotonically. The longitudinal axis of the cylindrical specimens was always parallel to the symmetry axis of the material. In addition, uniaxial tensile and compressive stress-strain properties in the directions parallel and perpendicular to the material symmetry axis were determined. The effective stress and effective strain of Grade ATJ graphite were calculated from combined and uniaxial stress test data. Correlation between the effective stress and the effective strain for the combined and uniaxial stress tests was satisfactory. Agreement between the biaxial stress-strain relations measured in the biaxial tests and the biaxial stress-strain relations predicted from the uniaxial stress-strain properties was also found to be satisfactory. The fracture strength of Grade ATJ graphite under combined stresses was compared with various theories of fracture. (auth)

31584 (CONF-701105–, pp 255-72) FORMULATION OF THE MECHANICAL BEHAVIOR OF ATJ GRAPHITE AT HIGH TEMPERATURE. McDonough, T. B. (General Electric Co., Philadelphia, Pa. Re-entry and Environmental Systems Div.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

The application of structural graphite to ballistic re-entry vehicle nose tips is current. Thermal stresses are a primary consideration for these designs. Generally design analyses are restricted to assumed linear elastic behavior, even though it is obvious from test data that the behavior is neither linear nor elastic at temperatures in excess of 4000°F. A formulation of the mechanical behavior appropriate for the above application is discussed. Generally design data is obtained from uniaxial tensile tests at a standard cross-head speed. Representative stress-strain curves appear consistent with a plasticity (rate independent) formulation. Alternatively available high temperature creep data suggests the need for a rate dependent viscoelastic formulation. A formulation which contradicts neither data is desirable. The plasticity formulation, which is rate independent, cannot agree with the creep data. A viscoelastic constitutive law was formulated on the basis of the creep data. Using this formulation, the response of a tensile specimen subjected to constant strain rate is predicted. The predicted response is consistent with both types of available data. Although the viscoelastic law was formulated on the basis of creep data, the material parameters may be evaluated from other types of test data. For this reason, the response of other test specimens is predicted and methods for evaluating the material parameters are identified. (auth)

31585 (CONF-701105–, pp 273-85) VISCOELASTIC REPRESENTATION OF ANISOTROPIC MECHANICAL BEHAVIOR OF GRAPHITE AT ELEVATED TEMPERATURES. Pugh, C. E.; Callahan, J. P. (Oak Ridge National Lab., Tenn.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

As a result of fabrication processes and other factors, the mechanical behaviors of many graphites exhibit varying degrees of anisotropy. At elevated temperatures, creep and relaxation mechanisms are operative and give rise to mechanical behavior which is both time and temperature dependent. These are some of the features which must be taken into account when developing constitutive equations applicable to these materials. A mathematical characterization of the time-dependent mechanical behavior of RVD graphite is discussed for temperatures ranging from 3500 to 5000°F. A set of temperature-dependent constitutive equations is given to describe the mechanical response of the material to a variety of loadings. Experimental results are used both to numerically evaluate parameters and to verify the resulting mathematical model. First, RVD graphite, a molded graphite, is characterized as transversely isotropic with the plane of isotropy normal to the direction of molding. For stress levels up to one-half of the nominal ultimate strength of the material, creep strains were observed to have linear dependences upon stresses. The constitutive equations used represent a transversely isotropic linear viscoelastic model and are formulated in terms of hereditary integrals. These relations contain five independent material properties: three strain ratios (Poisson's ratios) and two creep functions. The strain ratios are temperature dependent, but independent of time, stress, and strain. Thus, the time-dependent character of the behavior is accounted for by two creep functions. Four of the five parameters were first evaluated at 4500°F by using data from with-grain (directions parallel to plane of isotropy) and across-grain (direction normal to the plane of isotropy) tensile tests and from with-grain creep tests. Temperature dependence is introduced into the model by considering data from with-grain tensile and creep tests conducted at 3500, 4000, and 5000°F. The experimental data on which this study is based did not provide information for the determination of the creep function which describes the shear behavior in planes normal to the plane of isotropy. The model as developed, however, allows predictions for a wide variety of problems which do not involve this type of shear behavior. Among these are plane strain, plane stress, and axisymmetric problems, when in each case the defining plane is the plane of isotropy. To provide a degree of verification, predictions based on these constitutive equations are shown to closely agree with results of across-grain tensile creep tests, with-grain and across-grain relaxation tests, and short time stress-strain behavior for three different strain rates. The good agreement found between the predictions and experimental results is significant, as these results are independent of those used in numerically evaluating the parameters in the constitutive equations. (auth)

31586 (CONF-701105–, pp 286-303) VISCOELASTIC REPRESENTATION OF THE BEHAVIOR OF GRAPHITE UNDER THE INFLUENCE OF NEUTRON IRRADIATION. Chang, S. J. (Oak Ridge National Lab., Tenn.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

A viscoelastic representation of the mechanical behavior of graphite under neutron exposure was developed and compared with experimental data for neutron-induced creep behavior. The mathematical model also includes provisions for the effects of neutron-induced swelling as well as thermal expansion. When exposed to neutron irradiation, artificial graphites generally experience internal heat generation, induced creep, and dimensional changes which are functions of the accumulated neutron exposure and the irradiation temperature. It was found that the linear viscoelastic model for thermorheologically simple materials is adaptable to the representation of experimental observations. In this model, the accumulated neutron exposure, which is in general nonuniform throughout the body, is identified as the "reduced time" variable. Temperature is included in the model as an additional parameter with no direct relation to the "reduced time," in contrast to the classical thermorheologically simple model. In addition, the constitutive equations are expressed in a form which characterizes a transversely isotropic material, since many nuclear-grade graphites exhibit this type of material symmetry as a result of fabrication processes. The application of these constitutive equations to the solution of generalized plane-strain problems for isotropic materials is also discussed. It was found that these viscoelastic solutions can be determined from associated elastic solutions. (auth)

31587 (CONF-701105–, pp 307-16) VISCOELASTIC RESPONSE OF GRAPHITIC MATERIALS IN IRRADIATION ENVIRONMENTS. Chang, T. Y.; Rashid, Y. R. (Gulf General Atomic, Inc., San Diego, Calif.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

A numerical method is presented for the stress analysis of reactor graphitic components under conditions of plane stress, plane strain, generalized plane strain, or axisymmetry. In the analysis, both the creep deformation and the radioinduced strains are the major concern. The mechanical response of the material is assumed to be linear viscoelastic and transversely isotropic. The constitutive relations are formulated in hereditary integral form, and the dependence of the material properties on temperature and neutron flux are considered. To illustrate the method, a numerical example on the analysis of a fuel element is presented. (auth)

31588 (CONF-701105–, pp 329-41) MODEL FOR THERMAL AND RADIATION STRESS AND STRAIN IN VISCOELASTIC, ORTHOTROPIC CYLINDERS, AND ITS APPLICATION TO BORATED-GRAPHITE ABSORBERS. Stevens, D. W.; Stansfield, O. M. (Gulf General Atomic, Inc., San Diego, Calif.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

An analysis has been conducted to determine stresses and displacements near the center of long viscoelastic cylinders. Stresses arise due to thermal expansion and radioinduced dimensional changes which are anisotropic in transverse planes (i.e., planes perpendicular to the axis of geometrical symmetry). The explicit solution for stress is made possible by the assumption of a linear creep law. The logic is given for a mathematical model that accounts for finite displacements. The model is used to predict stresses and displacements in borated-graphite absorbers used in the Peach Bottom high-temperature gas-cooled reactor (HTGR). It is predicted that fracture will not occur in the absorbers. This conclusion is presented with the reservation that there is considerable uncertainty regarding radioinduced dimensional changes due to the small amount of available data. However, the assumed values for these parameters are believed to be conservative. (auth)

31589 (CONF-701105–, pp 375-405) ANISOTROPIC ELASTIC-PLASTIC STRESS ANALYSIS OF AXISYMMETRIC SOLIDS. Weiler, F. C. (Aerotherm Corp., Mountain View, Calif.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

Advanced stress analyses for solid bodies of revolution are described and discussed. Emphasis is placed on the analysis of anisotropic materials that have temperature dependent properties and are exposed to very high temperatures, such as graphite in reentry vehicle nose tips. Classical theories and various mathematical descriptions used in anisotropic elastic-plastic-thermal analyses are reviewed and compared. The constitutive equations presently being used and the OASIS code are described briefly, and it is shown that for application to graphite at reentry temperatures, the mathematical descriptions must be properly modified to account for anisotropy and temperature dependence effects. The necessity for using both an incremental theory and an incremental method of solution to obtain an adequate description of what actually happens to the material is emphasized. The great difficulty of obtaining correct solutions without adequate material characterization and the requirement for optimum coding techniques to minimize computer time are also discussed. (auth)

31590 (CONF-701105-, pp 406-19) ASAAS: ASYMMETRIC STRESS ANALYSIS OF AXISYMMETRIC SOLIDS. Crose, James G. (Aerospace Corp., San Bernardino, Calif.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

A description is presented of a finite element method and the associated computer program to solve the thermal stress problem of asymmetrically heated axially symmetric bodies with temperature-dependent properties. The program is presently oriented towards analysis of graphite nosetips on reentry vehicles that undergo angle-of-attack heating, but it can be applied with only slight modification to a wide class of three-dimensional stress analysis problems. At the present time, the analysis is restricted to elastic, orthotropic material properties. A two-dimensional axisymmetric triangular element is extended to a three-dimensional representation of the media by a Fourier series expansion of the problem variables in the circumferential direction. In the case of material properties that do not vary circumferentially, the system of resulting equations uncouples into the individual harmonics and solutions for each harmonic can be obtained independently. In the present case, the material properties are allowed to have circumferential variations, the harmonics are fully coupled, and the solutions of all the equations must be obtained simultaneously. By ordering the simultaneous equations in a particular manner, a banded stiffness matrix is formulated. The solution is obtained through the use of a banded square-root Cholesky scheme which is blocked according to the amount of immediate-access storage available in the particular computer being used. For a given amount of computer storage, there is a limit on the number of harmonics and nodal point connectivity that can be employed. However, with the present generation of computers, ample storage is available for solving most practical problems. (auth)

31591 (CONF-701105–, pp 420-7) THERMAL/STRUCTURAL ANALYSIS OF DESIGNS USING GRAPHITE MATERIALS. Teter, R. D. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

The development of digital computer codes has made it possible for the analyst to accurately predict the behavior of large complex structures including shells, frames, and general three-dimensional solids. The finite element codes have been extensively developed for this purpose and are routinely used to analyze a variety of graphitic designs. The application of several of these codes to a range of structural problems is presented, and specific examples of designs using graphitic materials are given. Illustrative examples are shown of the computer plot routines that automatically obtain contour maps and data plots of stresses, strains, temperatures, etc., and thereby reduce the time consuming, error-prone, manual manipulation of the results. The graphical input-output data routines of the computer codes enable the analyst to more easily and rapidly interpret the results and aid him in conveying this information to others. Of particular interest are the input data plots which eliminate errors and assure that the problem solved is indeed the one of interest. (auth)

31592 (CONF-701105–, pp 428-54) STRUCTURAL ANALYSIS OF CARBON AND GRAPHITE FILAMENT WOUND HEATSHIELDS FOR REENTRY HEATING ENVIRONMENT. Schamaun, J. T. (Sandia Labs., Albuquerque, N. Mex.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

Structural analysis methods and results of a reentry-vehicle heatshield manufactured of carbon filaments are discussed. The matrix is deposited by carbon vapor deposition and subsequently heat treated at high temperatures. The analysis methods are an extension of orthotropic techniques used in analyzing glass-epoxy filament wound materials. Included is a basic description of some unique thermostructural problems, associated with filament wound carbon or graphite material, which do not occur in designing homogeneous, isotropic shells. (auth)

31593 (CONF-701105–, pp 455-72) THERMOSTRUCTURAL SENSITIVITY ANALYSIS FOR GRAPHITIC NOSE TIPS. Michalak, R. J.; McDonough, T. B.; Connell, W. (General Electric Co., Philadelphia, Pa. Re-entry and Environmental Systems Div.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

In order that some priority can be given as to which property is the most "design influencing", a material property sensitivity study was performed on a graphitic nose tip. The philosophy involved in this was to vary the magnitude and/or the trend of a particular property with temperature consistent with the variation evident in measured design data. The sensitivity study was conducted in two parts. In the first, the temperature gradients were assumed invariant and the effect of variable mechanical properties were studied. In the second part, the mechanical properties were assumed invariant and effect of variable thermal parameters was studied. The input variables to the sensitivity analysis are those which are used to predict the ablation characteristics, temperature profiles and the state of stress of the re-entering body. The specific material properties which were varied are elastic moduli (with and across grain), shear modulus, Poisson's ratio, thermal expansion coefficient (with and across grain), thermal conductivity, total hemispherical emittance, and specific heat (high temperature behavior). In addition to an absolute dependence on strain to failure, the results demonstrate primary reliance on thermal coefficient of expansion, thermal conductivity and elastic modulus trend with temperature. (auth)

31594 (CONF-701105–, pp 475-87) DEFORMATION AND FRACTURE MECHANISMS IN POLYCRYSTALLINE GRAPHITES. Smith, Morton C. (Los Alamos Scientific Lab., N. Mex.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

Manufactured polycrystalline graphites are brittle solids which normally contain from 15 to 30% of void volume in the form of cracks, shrinkage cavities, and blowholes. In mechanical analyses, however, they are assumed to be structurally continuous and capable both of plastic deformation and of strain-hardening. Justification for these assumptions was found in the unique combination of crystal structure and defect structure that exists in a polycrystalline graphite. This structural situation permits microcracks to form at small "background" defects, extend over short distances, and stop, after which—at higher stress—additional cracks form elsewhere and undergo similar cycles. The dilatation represented by crack opening produces macroscopic strain and, if the volume increase is taken into account, it can be treated in the same terms used for plastic deformation. The requirement for higher stress to produce each successive generation of cracks is the equivalent of strain-hardening. And the point-to-point load-transfer occurring when growth of one crack stops and that of another begins demonstrates the structural continuity required by continuum mechanics. Fracture occurs when, locally, the concentration of microcracks becomes sufficient so that they overlap and join to form a discontinuous macrocrack of critical size, which then propagates at an increasing rate. Microcracks form in highest concentration in the regions of stress-concentration adjacent to large, "disparate" defects. The fracture path, therefore, extends preferentially from one large defect to the next. Between them it is controlled jointly by the stress field and by the nature and distribution of background defects, and normally it is branching and irregular. (auth)

31595 (CONF-701105–, pp 490-500) SIMPLIFIED APPROACH TO PREDICTING THE ONSET OF FRACTURE IN BRITTLE MATERIALS. Andrae, R. W. (Los Alamos Scientific Lab., N. Mex.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

A method of analysis is presented for predicting the initiation of fracture in brittle materials, e.g., graphites and particulated composites. It combines conventional stress-distribution analysis with a fracture criterion that indicates whether or not the stresses will cause the material to crack. Only the initiation of a crack is considered; subsequent crack propagation is disregarded. Strain energy and work are the two basic parameters of the fracture criterion. The validity of this approach was checked in tests of notched beams, notched tensile specimens, and thin, washer-like specimens subjected to thermal gradients. Two graphites (ATJ and AUC) and several hot-pressed particulated composite materials were used. In all cases, test results and analytical predictions were in excellent agreement. (auth)

31596 (CONF-701105–, pp 501-13) MECHANICAL PROPERTIES OF GRAPHITES AND THEIR RELATION TO A PHYSICALLY BASED STATISTICAL THEORY OF FRACTURE. Buch, J. D. (Aerospace Corp., Los Angeles, Calif.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

A simple single scheme was developed from which several properties of graphites may be rationally understood. When applied to the tensile properties of a non-porous polygraphite, the theory appears to give fairly accurate estimates of strength, specimen effects, the effect of grain size and anisotropic grain orientation, and to be a direct physically based statistical theory of fracture. These concepts are related since they are all affected by the same fundamental flaw, or inherent characteristic, which limits the mechanical properties of graphite. A logical set of candidates for this fundamental flaw is pointed out and the value of these concepts in correlating the mechanical properties of various forms of graphite are demonstrated. (P.C.H.)

31597 (CONF-701105–, pp 514-32) BIAXIAL MECHANICAL PROPERTIES OF AXF-5Q GRAPHITE TO 4000°F. Jortner, J. (McDonnell Douglas Astronautics Co., Los Angeles, Calif.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

Fracture strengths and strains of AXF-5Q, a fine-grained isotropic polycrystalline graphite, have been measured in several biaxial stress states at 70, 3000, and 4000°F. Hollow cylindrical specimens of one-inch inner diameter, 0.050-inch wall thickness, and one-inch gage length were simultaneously pressurized internally and loaded axially to obtain, with different ratios of load to pressure, a variety of stress states covering the tension-tension and compression-tension quadrants of the biaxial stress plane. Supplementary uniaxial tensile and compressive data were obtained on solid cylindrical specimens. The fracture data showed that the maximum tensile stress at failure was decreased below the uniaxial tensile strength in the tension-tension quadrant, was equal to the uniaxial tensile strength in the compression-tension quadrant for applied compressive stresses which were less than the applied tensile stress, and decreased towards zero as the compressive stress approached the uniaxial compressive strength. Biaxial strength increased with increasing temperature in approximately the same ratio as did the uniaxial tensile strength. The strain data showed that, as might be expected from consideration of Poisson's effect, the maximum tensile strain at failure was smaller in biaxial tension, and greater in compression-tension, than in uniaxial tension. (auth)

31598 (CONF-701105–, pp 533-46) GEOMETRICAL PARAMETERS AFFECTING THE FRACTURE TOUGHNESS OF GRAPHITE. Yahr, G. T.; Valachovic, R. S. (Oak Ridge National Lab., Tenn.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

The fracture mechanics approach for predicting brittle fracture has come to be widely accepted as a valuable technique for structural design. Since graphite fails in a brittle manner, the application of fracture mechanics to this material is natural. The results of a study of the effects of several geometrical parameters on the stress-intensity factor at onset of rapid crack propagation, K, are reported. For plane-strain fracture, K_c is more specifically referred to as K_{Ic}, the material property used in fracture mechanics analyses. Suitable specimen designs for measurement of K_{Ic} for graphite were determined. Several specimen configurations were tested from two graphites, ATJ and AXM. The effects of specimen size, specimen width, notch sharpness, and notch depth on the values of K_c obtained from tests of notched beams in four-point bending were investigated. The most critical geometrical parameter of the notched beams was found to be notch sharpness. Beams as small as 4 in. long by $^3/_{16}$ in. wide by $^7/_{16}$ in. deep were found to give valid K_{Ic} values when the notch was sufficiently sharp. Values of K_c were also determined from three other types of specimens: notched tensile specimens, double cantilever beams, and compact tension specimens. The values of K_c from the different specimen types were compared, and recommendations are made regarding suitable specimen geometries for measuring the fracture toughness of graphites when the specimen size is limited. The use of fracture mechanics to predict the strength of specimens which fracture at naturally occurring flaws rather than at gross machined notches was also explored. The flaws that would produce fracture at the loads that broke unnotched specimens of ATJ and AXM graphites were comparable in size to flaws observed in photomicrographs of these materials. (auth)

31599 (CONF-701105–, pp 547-67) APPLICATION OF WEIBULL STATISTICAL THEORY TO THE STRENGTH OF REACTOR GRAPHITE. Price, R. J.; Cobb, H. R. W. (Gulf General Atomic, Inc., San Diego, Calif.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

The Weibull statistical theory for the strength of brittle materials has the potential for predicting failure probabilities in structures of any volume or stress state, including multi-axial stresses and stresses which vary with position. The Weibull equations were used to calculate failure probabilities in four-point bend-test samples and in internally pressurized thick-walled tubes with either zero axial stress or with a super-imposed axial tensile stress. The calculations predict that the ratio of the median strength of samples with non-uniform stesss systems, σ_{nu}, to the median tensile strength, σ_t, is given by expressions of the form: $(\sigma_{nu}/\sigma_t) = (V_t/V_{nu})^{1/m} \times$ (stress distribution term) where V_t and V_{nu} are the volume of the tensile samples and non-uniform stress samples respectively, and m is the Weibull modulus. The stress distribution term depends on the Weibull modulus, the way the stress varies with position, and the biaxial stress ratio within a small volume element of material. Some predictions of the Weibull theory were tested against the results of tensile tests, bend tests, and tube-burst tests with and without superimposed tensile stress, performed on H-327 graphite. It was found that the distribution of strength values among a group of tensile samples with the same orientation and log location is described equally well by a Weibull or a Gaussian distribution. The strength measured from the tube-burst tests showed the expected dependence on wall thickness, but the absolute strength values were higher than predicted by Weibull theory. The moduli of rupture obtained from the bend tests were lower than the theoretical predictions. However, when the volume-ratio term in the above equation was set equal to 1 and the stress-distribution term alone was used, the calculated values were in reasonable agreement with the observations for all series of tests. Thus, the Weibull equations correctly predicted the changes in failure probability due to non-uniform stress distributions, but over-estimated the dependence on sample volume. (auth)

31600 (CONF-701105–, pp 571-7) THERMAL DISC TESTS FOR THE EVALUATION OF GRAPHITE FOR AEROSPACE APPLICATION. Meyer, R. A. (McDonnell Douglas Astronautics Co., La Jolla, Calif.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

The thermal disc test was used to evaluate the thermal stress resistance of bulk graphites considered as candidate materials for aerospace applications. These graphites were evaluated on a relative basis by comparing the energy they absorbed without fracturing. The test samples were 1 to 1¼ in. in diameter by $^1/_{10}$ in. thick. Thermal stress was introduced by heating the center of the disc with an electric arc on each face of the sample. More than 20 types of graphites from seven sources were evaluated. Correlations were found between the energy to fracture and the grain size. Generally, finer grain structure sustained higher energy before fracturing. However, there was evidence that an optimum size of grain may exist: some of the finest structures had a fracture threshold below grades with slightly coarser structure. The influence of other physical properties is also discussed in terms of the sensitivity toward fracturing. The usefulness of this type of test as a screening device is reviewed. (auth)

31601 (CONF-701105–, pp 578-89) TEMPERATURE/STRESS TEST FOR POLYGRAPHITES. Starrett, H. S. (Southern Research Inst., Birmingham, Ala.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

A test has been developed that causes tensile fractures of the proper mode and at the proper location of test specimens made of polygraphites. A disc with a hole in the center is heated inductively at the outer periphery at rates to provide a temperature rise rate of the order of 2000°F/sec. Fracture occurs radially at the inner periphery during heatup at typically 2 to 4 seconds and may extend partially or totally through the section. In some cases, the disc may be wedged or rimmed at the outer periphery. A common geometry has been found that has fractured all polygraphites tried to date, including AXM, AXF, ATJ–S, ATJ, and G–90. A rapid strain analyzer with an uncertainty of about ½ to 1 percent at any point on the scale is being developed to monitor the strains at the inner hole. Stress and deformation analyses of the disc are also being developed. When these two additional inputs are completed, studies of constitutive relations and failure criteria will be made. As a corollary to the main effort, the partially fractured discs provide double-cantilever prenotched specimens for subsequent studies of fracture mechanics. (auth)

31602 (CONF-701105–, pp 590-600) THERMAL SHOCK RESISTANCE OF EXPERIMENTAL GRAPHITES. Valachovic, R. S.; Yahr, G. T. (Oak Ridge National Lab., Tenn.); Napier, J. M. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

The potential of a number of experimental graphites for applications where thermal stress resistance is important was evaluated. The test method for determining the relative thermal shock resistance of graphites consists of rapidly heating the center of a thin disk of graphite with an electric arc and maintaining a much lower temperature of the disk's periphery. The resulting radial temperature difference creates a tensile stress in the outer regions of the disk, and the disk will fracture if the stress is higher than the particular material will withstand. The rate at which heat is introduced at the center of the disk determines the temperature gradient and the magnitudes of the resulting stresses in the outer regions of the disk. The amount of power required to fracture a disk is a relative measure of the thermal shock resistance of the graphite being tested. The test apparatus consists of a heat source, a support for the disk, a power supply, controls, and recording instruments. An inert-gas shielded nonconsumable-electrode arc welder is the heat source. A water-cooled copper plate with a hole in the center supports the graphite disk during the test. The arc variables such as cover gas composition and flow rate, electrode size, and distance from electrode to specimen are held constant so that the power introduced into heating the disk does not vary from one test to another. The total power expended by the welding machine is measured for each specimen, and the lowest power level which consistently produces fracture of an identical group of specimens is a measure of the material's resistance to thermal shock. This is referred to as the threshold power level and is proportional to the thermal shock resistance of the material. Series of developmental graphites fabricated at the Oak Ridge Y-12 Plant of Union Carbide Nuclear Division was tested to determine the interrelated effects of various raw materials and manufacturing techniques on the thermal shock resistance of the finished material. (auth)

31603 (CONF-701105–, pp 601-15) CORRELATION OF EXPERIMENTAL CARBON AND GRAPHITE ABLATION DATA. Auerbach, I.; McVey, D. F.; McBride, D. D. (Sandia Labs., Albuquerque, N. Mex.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

Graphite and carbon serve as thermal protective materials on reentry vehicles by ablating slowly at very high temperatures. To evaluate and compare ablation of various materials in several test facilities, a relationship is presented in which recession rate is related to stagnation pressure and gas enthalpy. The proportionality constant acts as the basis for the comparisons. It was found that material and testing variabilities permitted little or no differentiation in the ablation performance of the seven bulk graphites and eight modifications of them. Five of the six test facilities used gave similar results. The results suggest that factors other than recession rate should be used as a basis for selecting a bulk graphite. (auth)

31604 (CONF-701105–, pp 641-52) EFFECTS OF PROOF TESTING AND ANNEALING ON AXF-5Q GRAPHITE. Jortner, J. (McDonnell Douglas Astronautics Co., Los Angeles, Calif.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

The influence of proof loading at room temperature on the tensile and compressive behavior of AXF–5Q graphite is described. It was found that specimens which survive a proof test at 90% of the average ultimate strength of the material, have strengths on second loading above the proof level. If the specimens were annealed at 2000°C after proof loading, the stress-strain behavior on second loading was the same as that on first loading. Residual strain effects and dimensional "permanent" sets resulting from proof loading appeared to be removed by the annealing process. The results favor the use of proof loading and annealing as a means of raising the lower bound design strength of AXF–5Q structural components. (auth)

31605 (CONF-701105–, pp 663-75) STATISTICAL CONSIDERATIONS ON THE STRENGTH OF NUCLEAR GRAPHITES: CHARACTERIZATION, IRRADIATION, AND DESIGN. Lungagnani, V.; Krefeld, R. (European Atomic Energy Community, Petten (Netherlands). Joint Nuclear Research Center). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

Because extreme scatter of fracture stress values is a usual characteristic of graphite, the mean strength is neither a satisfactory basis for design stress considerations, nor an acceptable criterion for property evaluation techniques. In order to define the strength in terms of a statistical distribution, tensile test measurements have been carried out on randomly selected specimens from a Gilso-carbon graphite. According to the weakest-link concept, the larger the specimen volume, the greater is the probability of finding a very weak link and thus a specimen of low strength. This correlation has been confirmed experimentally and, in the formulation proposed by Weibull has been used for characterizing the mechanical behavior of graphite. The same approach has been used to describe the extent and the trend of change of mechanical properties in materials subjected to neutron irradiation. Finally, a very simple attempt has been made, towards the use of the Weibull parameters for the design of graphite components. (auth)

31606 (CONF-720207–(Absts.)) RADIATION DAMAGE CONFERENCE, UNIVERSITY OF NEW SOUTH WALES, 8–11 FEBRUARY 1972. Programme and Abstracts. (New South Wales Univ., Kensington (Australia)). 24p.

Twenty-four abstracts are presented. They are from papers dealing with neutron radiation effects on various materials including carbon fibers, crystals, and alloy systems both on a macro- and micro-scale. Sections are also devoted to novel methods in studying damage, and channeling, and sputtering. (Australia)

31607 RADIATION RESISTANCE OF RUBBER AND PLASTIC CABLES. Fujita, H.; Okada, M.; Mio, K.; Obuchi, H.; Terasaki, K. (Dainichi-Nippon Cables, Ltd., Osaka). Dainichi Nippon Densen Jiho; No. 48, 40-55(Jul 1971). (In Japanese).

A study was made on the effects of radiation on control cables, in which various insulating rubber and plastic materials as well as cables themselves were studied using a 15,000 Ci cobalt-60 gamma radiation source. The changes in the physical and electrical properties of the cables and materials after irradiation are reported. The cables and materials irradiated were four kinds of ethylene propylene rubber, two kinds of silicon rubber, natural rubber, chlorosulfonated polyethylene, nitrile rubber, epichlorohydrin rubber, four kinds of chemically crosslinked polyethylene, two kinds of poly(vinyl chloride) chemically crosslinked polyethylene containing a flame retardant agent (Nonflene-CF), poly (amide-imide), and electrical tapes. The maximum dose rate is expected to be 1×10^3 R/h outside the primary shield where the cables are designed to be installed. Considering the expected life of the nuclear reactor to be 40 years, the maximum total dose may approach to 3.5×10^8 R for which the experimental results showed that ethylene propylene rubbers and chemically crosslinked polyethylenes are the best suited. These materials are also expected to be used for even higher exposure doses. (auth) (Japan)

31608 INFLUENCE OF REFRACTORY ELEMENTS ON THE ANNEALING OF CARBONACEOUS MATERIALS. Lukina, E. Yu.; Osokina, O. A.; Rakcheeva, V. I.; Perkova, G. A. Tsvetn. Metal.; No. 10, 47-50(Oct 1971). (In Russian).

A study was made of irreversible distortion, weight loss, and coefficients of thermal expansion of carbonaceous materials with additions of Ti, Zr, Si, and B during the annealing process of such materials. The test samples were 15 and 50 mm long and 15 mm in diameter, pressed from a coke-like composition with 80% filler and 20% binder. The filler was a pyrolyzed petroleum coke, and the binder was coal tar pitch. The metal additives affected the shrinkage and loss in weight of the samples. (K.S.W.)

31609 OXIDATION OF REACTOR GRAPHITE. Burdakov, N. S.; Turdakov, V. N. At. Energ. (USSR); 32: No. 4, 324-6 (Apr 1972). (In Russian).

Graphite having a density of 1.6 to 1.7 g/cm^3 and a porosity of 15 to 20% was subjected to oxidation in microconcentrations of O_2. The oxidation rate was measured by the accumulation of CO/CO_2 or by the weight loss. Experimental temperatures ranged from 450 to 1,025°C. The effect of O_2 concentration (0.005 to 21%) on the oxidation rate was studied at various temperatures. (K.S.W.)

31610 POROSITY EFFECTS IN POLYCRYSTALLINE GRAPHITE. Wagner, P.; O'Rourke, J. A.; Armstrong, P. E. (Los Alamos Scientific Lab., N. Mex.). J. Amer. Ceram. Soc.; 55: No. 4, 214-19(Apr 1972).

Thermal and physical properties of a series of porous, polycrystalline graphites were measured. The solid matrix material was characterized by x-ray diffraction measurements of crystallite size, interplanar spacing, and anisotropy. The pore structure was examined using electron micrography, porosimetry, permeability, and helium density measurements. Thermal and electrical conductivities and elastic modulus measurement results were correlated with the fractional porosities of the graphites. (auth)

31611 SHEAR STRENGTH OF END SLABS WITH AND WITHOUT PENETRATIONS IN PRESTRESSED CONCRETE REACTOR VESSELS. Karlsson, Bengt Ingvar. Urbana, Ill.; Univ. of Illinois (1971). 388p. University Microfilms Order No. 72-12,237.

Thesis.

The shear strength of end slabs of prestressed concrete reactor vessels was studied. The configuration of the vessels was that of a cylinder bounded by two flat slabs. The vessels were prestressed circumferentially and longitudinally and subjected to an internal pressure. Vessels with solid end slabs and vessels with penetrations in the end slabs were studied. Six pressure vessels were tested. The only systematically varied variables were the amount and location of penetrations in the end slabs. The vessels failed at internal pressures between 3000 and 3500 psi with no apparent relation between the failure pressures and the amount and location of penetrations. A shear failure is characterized by the following mechanism: A critical inclined crack is initiated at about mid-height of the slab. The development of this crack tends to transform the end slab into a dome. Collapse occurs by failure of the concrete in the dome under the influence of multi-axial compressive stresses. A set of equations has been presented that can be used in prediction of the internal pressure at which the inclined crack is initiated. There are two stages involved in analyzing the shear strength of the end slab: (1) determining the shape of the cryptodome that is resisting the internal pressure and (2) calculating the stress conditions in the cryptodome. The shape of the cryptodome was determined by assuming that the inclined crack passed through the points at which the principal tensile strains had their maximum values. This assumption was useful in determining the major part of the inclined crack. However, sometimes it leads to an underestimation of the thickness at the center of the dome. The stresses in the cryptodome were calculated assuming that the concrete has a linear force-deformation relationship in compression. The calculated stresses were compared by using a failure criterion based on Mohr's stress circles. Penetrations that are located in the section in which the inclined crack is initiated precipitate the formation of the crack. This effect is included in the equations that were suggested for predicting the initiation of the inclined crack. In the experiments that were performed, the penetrations did not affect the strength of the vessels. However, it has not been possible to give a "rule of thumb" of the number and size of penetrations that can be introduced without affecting the strength of the slab. Results of applying the design method indicate that, depending on the geometrical shape of the vessel and the location of penetrations, even a few penetrations may reduce the strength of the slab. (Diss. Abstr. Int., B)

31612 PREPARATION OF SYNTACTIC CARBON FOAM. Benton, S. T.; Schmitt, C. R. (Union Carbide Corp , Oak Ridge, Tenn.). Carbon; 10: No. 2, 185-90(Apr 1972).

A pressure molding technique for preparing syntactic carbon foam having high compressive strength and low bulk density (>500 lb/in.^{2} at 0.18 g/cm^3) is described. The use of hollow phenolic resin and carbon microspheres of various types, particle size, and wall thickness, along with different carbonaceous binder materials, solvents, and molding pressures prior to coking at 900°C were some of the major variables investigated in relation to compressive strength and density characteristics of the syntactic carbon foams. (auth)

31613 EFFECT OF PRE-STRESSING ON THE THERMAL EXPANSION AND YOUNG'S MODULUS OF GRAPHITE. Hart, P. E. (Battelle Memorial Inst., Richland, Wash.). Carbon; 10: No. 2, 233-6(Apr 1972).

Results are reported of the effect of compressive, tensile, and isostatic prestressing on the thermal expansion and Young's moduli of AXF, ZTA, and ATJ graphites. Measurements were made on 0.5 in. dia. samples, prestressed at 30, 60 and 90% of measured strength in tension and compression at room temperature, or hydrostatically loaded to 15,000 and 30,000 lb/in.^{2}. Thermal expansion data are summarized for the three graphites at 800°C. Changes in Young's moduli and density at room temperature are reported for AXF and ATJ materials before and after annealing at 1300°C. (UK)

31614 IRRADIATION-INDUCED LENGTH CHANGES OF GLASSY CARBON. Gray, W. J. (Battelle Memorial Inst., Columbus, Ohio); Morgan, W. C.; Cox, J. M.; Woodruff, E. M. Carbon; 10: No. 2, 236-8(Apr 1972).

Samples of glassy carbon which had undergone maximum processing temperatures of 1000, 2000, or 3000°C were irradiated at 600 ± 50°C to 1.64×10^{21} n/cm^2 ($E > 0.18$ MeV). The samples were in the form of hollow rods and cylinders. Changes in length, weight, apparent crystallite size, and lattice spacing are reported. Contraction rates were high compared with nuclear graphite whereas changes in other physical properties were much less. The changes in apparent crystallite size on irradiation are compared with results obtained by Bokros on pyrolytic carbon. (UK)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

31615 CANDU SUCCESS WILL BOOST PROCESSORS. Can. Chem. Process.; 56: No. 1, 51-3(Jan 1972).

The success of the Canadian nuclear energy programme, based on natural uranium and heavy-water moderator (the "CANDU" system) is discussed in relation to its significance for the chemical industry. Criticism by the Senate Special Committee on Science Policy is rebutted. Possibilities for the future include a plutonium recovery plant, an isotope separation plant, and fabrication of thorium fuel. A solvent extraction process for plutonium, using tertiary amines, has been developed by Atomic Energy of Canada Ltd. (AECL). The Girbitol–Spevak heavy-water process, based on H_2O/H_2S exchange, has proven a failure at Glace Bay, N. S., but the CGE/Lummus plant at Pt. Hawkesbury, N. S., is successful, and two new units are being built at Douglas Point, Ont. In 1975, Canada should produce at least 1600 tons of D_2O, and become an exporter. AECL has developed a D_2O process based on H_2O/amine exchange. CANDU power stations now cost twice as much as coal-burning stations, but produce electricity at 86% of the cost of the latter. The sealed fuel bundles prevent hazard from fission products. (Canada)

Accountability and Safeguards

Refer also to abstracts 30645, 30733, 30921, and 31143.

31616 (BNL–50329) STATISTICAL BASIS FOR INTERNATIONAL INSPECTION ACTIVITIES: ALLOCATION OF EFFORT AND DRAWING OF TECHNICAL CONCLUSIONS. Marcuse, W.; Epel, L. G. (Brookhaven National Lab., Upton, N. Y.). Jan 1972. 23p. (CONF-711037–3). Dep. NTIS.

From Panel on quantitative data and results of systems analysis and integral tests; Vienna, Austria (4 Oct 1971).

A tool has been created that may be useful to agency decision makers in objectively and quantitatively assessing the implications of their choice of policy variables, including significant quantities (SQ), credibility parameters (β risk), false alarm parameters (α risk), and the implied inspection effort. The tool may be used by agency planners to allocate available agency effort to maximize its effectiveness. The tool may also be used by agency analysts to assess the incremental gain or loss in quantitative terms of increases or decreases in agency in-plant inspection effort. A framework for evaluating material-unaccounted-for (MUF) is provided. This framework should assist the agency in arriving at the statement required by paragraph 30 of INFCIRC/153. (auth)

31617 (BNL–50330) INTEGRATED SAFEGUARDS EXPERIMENT AT A PLUTONIUM FUELS LABORATORY. Suda, Sylvester C.; Marcuse, William (Brookhaven National Lab., Upton, N. Y.). Jan 1972. 31p. (CONF-711037–2). Dep. NTIS.

From Panel on quantitative data and results of systems analysis and integral tests; Vienna, Austria (4 Oct 1971).

An integrated experiment was performed during the period August–December, 1970 at the General Electric Company Vallecitos Plutonium Laboratory located at Pleasanton, California. The major findings of this experiment are presented. The experiment was designed to take advantage of the in-plant nondestructive instrumentation being demonstrated under the Plant Instrumentation Program. The primary goal of ISE to demonstrate the feasibility of a fully measured material balance based on a combination of nondestructive and normal chemical analytical measurements. Results are presented for two historical campaigns (which were not completely measured) and two fully measured production campaigns. In addition to the quantitative results, problems in making measurements, weaknesses of NDA, problems in determining limits of error, and other problems associated with the experiment are discussed. A summary of conclusions useful to safeguards is included. (auth)

Disposal and Storage

Refer also to abstracts 30940 and 31042.

31618 (ICP–1005) SAFETY ANALYSIS REPORT FOR THE ICPP HIGH-LEVEL SOLID RADIOACTIVE WASTE STORAGE FACILITIES. Lohse, G. E. (Allied Chemical Corp., Idaho Falls, Idaho). Jan 1972. Contract AT(10-1)-1375. 190p. Dep. NTIS.

At the Idaho Chemical Processing Plant, radioactive solid wastes resulting from fluidized-bed calcination of extraction-column raffinates and nuclear facilities decontamination solutions are stored in stainless steel bins contained within buried concrete vaults. A safety analysis of the storage facilities indicates that they are capable of withstanding natural occurrences such as earthquakes, tornadoes, high winds, or floods without serious damage or spread of radioactive materials to the environment. (auth)

31619 (ICP–1007) DISPOSAL OF RADIOACTIVE LIQUID-ORGANIC WASTES AT THE ICPP. Cole, H. S. (Allied Chemical Corp., Idaho Falls, Idaho). Mar 1972. Contract AT(10-1)-1375. 19p. Dep. NTIS.

At the Idaho Chemical Processing Plant, a slightly radioactively contaminated kerosene–TBP mixture, from the solvent extraction operation, is disposed by burning with an ordinary household-type oil burner at approximately 20 l/hr. Prior to burning, the kerosene is processed through a steam stripper at 35 l/hr to remove radioactive contaminants and other impurities. The combustion gases are released to the atmosphere through the ICPP stack. Decontamination factors of 10^2 to 10^4 on radioactive contaminants are achieved in the steam stripper, resulting in release rates to the ICPP stack well below locally established guidelines. (auth)

31620 (ORNL–4762) CONSIDERATIONS IN THE LONG-TERM MANAGEMENT OF HIGH-LEVEL RADIOACTIVE WASTES. Gera, Ferruccio; Jacobs, D. G. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 151p. Dep. NTIS.

High-level radioactive wastes generated by the reprocessing of spent fuel elements in the projected nuclear power industry require the development of an organic waste management scheme. The presence in these wastes of long-lived transuranics requires assurance of waste containment for a time period of the order of several hundreds of thousands of years. For such long time periods only deep geologic formations offer the stability required for preserving the necessary degree of containment. Projections are made of the amounts of radioactive wastes accumulated to the year 2020. Important radionuclides in the waste are compared on the basis of their potential hazard to mankind over their entire physical lifetime. On the basis of these considerations, it seems that the most prudent scheme of management of these wastes involves solidification with final disposal into a suitable deep geologic formation in such a manner that further handling will be minimized. The characteristics of products from various suggested solidification processes are compared. The conditions of interim storage of high-level solid waste are reviewed, and possible mechanisms of activity release from the storage facility are considered. In order to insure safe containment of the waste for hundreds of thousands of years, the possible rate of several geologic processes capable of affecting the disposal formation must be estimated. Possible mechanisms of activity release from the deep geologic formation are described. (auth)

31621 (TID–3311(Suppl.3)) RADIOACTIVE WASTE PROCESSING AND DISPOSAL. (Technical Information Center (AEC), Oak Ridge, Tenn.). Apr 1972. 594p. Dep. NTIS.

The 2249 references were selected from NSA, Vol. 21 (1967) through issue 4 of Vol. 26 (1972). The subject indexes originally prepared for the papers are used as abstracts and to provide a general subject index. Citations are arranged in ascending order of original NSA abstract numbers. Corporate and personal author and report number indexes are included. (M.C.G.)

31622 (WASH–1202) PLAN FOR THE MANAGEMENT OF AEC-GENERATED RADIOACTIVE WASTES. (Division of Waste Management and Transportation (AEC), Washington, D. C.). Jan 1972. 43p. GPO $0.50.

Plans for controlling the releases of radioactivity and ensuring the safe storage of radioactive wastes generated by past, present, and future operations of the AEC are presented. The basic and fundamental objective of these plans is to handle wastes at all times in a manner: that will not endanger the health and safety of its employees or the public; that will not have an adverse impact on man's environment or on the ecology; and that will be accepted by the public. (auth)

31623 CLASSIFICATION OF UNIRRADIATED PLUTONIUM SCRAP. ANSI N15.10-1972. New York; American National Standards Institute, Inc. (1972). 25p.

A standard is presented for classifying scrap material containing the element Pu. This standard provides a classification system with inherent flexibility which will provide a means for facilitating activities in the nuclear industry relevant to the classifications. The classification codes are defined, and the coded classifications are given for Pu-containing materials in the following categories: unalloyed metals; alloyed metals; compounds; combustibles; noncombustibles; solutions; and process residues. (L.C.L.)

31624 RADIOACTIVE WASTE MANAGEMENT AND RADIATION EXPOSURE. Goldman, Morton I. (NUS Corp., Rockville, Md.). Nucl. Technol.; 14: No. 2, 157-62(May 1972).

Examination of the waste discharges from operating nuclear power plants results in estimates of public exposure related to the proposed numerical guides for effluents from light-water-cooled nuclear power plants. In-plant radiation exposures are also summarized for a number of these facilities, both on an individual and population basis. Under present waste management philosophies (which include augmented BWR off-gas holdup), in-plant population exposures may be about 100 times those of the public and unreasonable restrictions on waste discharges could increase rather than reduce the radiation exposure of the total population. (auth)

31625 MEASUREMENTS ON THE RELEASE OF GASEOUS ACTIVITY FROM A SHORT STACK. Hunt, J. C. R. (Cambridge Univ., Eng.). Atmos. Environ.; 6: No. 4, 289(Apr 1972).

Referring to the work of Radcliffe and Fraser (Atmos. Environ.; 5: 193 (1971)) the author suggests that the flow conditions maintained during the tests are not remotely described by the Scriven and Moore model as claimed. Reasons are given. It is stated that such models have their uses but that their limitations must be appreciated. (UK)

Handling Equipment and Procedures

Refer also to abstracts 31040, 31043, 31044, and 31168.

31626 (AAEC/LIB/Bib-342) URANIUM FIRE HAZARDS. A Bibliography. Literature Search Covers the Period 1949–1972. McDonald, C. J. (comp.) (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar 1972. 4p. Dep. NTIS (U. S. Sales Only).

The search covers the period 1949 to 1972 and thirteen references are listed together with a citation for an abstract for each item. (Australia)

31627 RADIOLOGICAL IMPLICATIONS OF UNCERTAINTIES IN HEAVY ELEMENT DATA. Clarke, R. H. (Central Electricity Generating Board, Berkeley, Eng.). pp 109-18 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

Thermal and fast commercial reactors are being designed to attain burn-ups approaching 100,000 MWD/te for both plutonium and thorium fuel cycles. Health Physics problems will arise from nuclides not previously considered significant. The effects of these extended fuel irradiations are being studied with the aid of a computer program which predicts the amounts of all the probable nuclides between mass numbers 230 and 250. The consequences of data uncertainties on the estimation of hazards arising during post-irradiation handling and processing of plutonium and thorium fuels are discussed. (10 references) (auth)

Transportation

31628 (ARH-1799) EVALUATION OF L-3 SHIPPING PACKAGE FOR SHIPMENT OF URANIUM-233 NITRATE (^{233}UNH) SOLUTION. Hoover, D. A. (Atlantic Richfield Hanford Co., Richland, Wash.). 6 Aug 1970. Contract AT(45-1)-2130. 6p. Dep. NTIS.

General characteristics of the three-liter, Type L-3, shipping package (also known as Model BP-1) were approved for the transport of ^{235}U and ^{239}Pu as both nitrate solutions and oxides by the Dept. of Transportation (DOT). Information to support a request for the addition of ^{233}UNH solution to the authorized commodities listed in DOT Special Permit No. 5330 for the Type L-3 shipping package is reported. (P.C.H.)

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstracts 31642, 31648, and 32294.

31629 (CERN–71-16(Vol.1 and 2), pp 855-70) MEASURED RADIATION LEVELS IN A CYCLOTRON VAULT, EXPERIMENTAL AREAS, AND ADJACENT AREAS. Bush, D. (Birmingham Univ. (England)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

Adequate calculation of the complex radiation fields around a cyclotron being almost impossible, measurements were made in the vault, experiment rooms, and adjacent areas of the University of Birmingham 60-in. cyclotron during operation. Results are presented for 10-MeV protons and 30-MeV $^3He^{++}$ beams Gamma dose rates from irradiated targets were also measured. In most cases, measurements of gamma and neutron dose rates were made by using film badges. It was found that, in the cyclotron vault and experimental areas into or through which the beam passes, neutrons are the major component of the total dose; in well-shielded areas, however, the gamma dose rate is dominant. (4 figures, 7 tables) (R.W.R.)

31630 (CERN–71-16(Vol.1 and 2), pp 871-92) RADIOACTIVITY INDUCED NEAR THE ORSAY SYNCHROCYCLOTRON. Choquet, R.; Maczynski, A. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). (In French).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

After a brief description of the Orsay synchrocyclotron, the residual activities around the synchrocyclotron, in the machine components themselves, and in the beam room are discussed. Radiation coming from irradiated targets is also covered. Doses received by the personnel at the synchrocyclotron are reported. It was found that one cannot naively presume the evolution of the residual activity around a synchrocyclotron. (12 figures, 3 tables) (R.W.R.)

31631 (CERN–71-16(Vol.1 and 2), pp 893-914) HIGH-INTENSITY ELECTRON ACCELERATOR RADIATION HAZARDS. Parker, Joseph R.; Engelke, Morris J. (Los Alamos Scientific Lab., N. Mex.).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The 30-MeV, 20-mA-peak electron linear accelerator (EPA) at LASL is discussed. Three kinds of radiation are generated, bremsstrahlung, neutron, and that from activities induced in the shielding and accelerator materials, and estimates of their intensities are made. The time dependence of the pulsed radiation is considered, since the readings of many instruments for measuring radiation would be erroneous for accelerators like the EPA. Intensity profiles, generation of radioactive air and noxious gases, water activity, and area-monitor detector criteria are briefly discussed. The EPA radiation measurements program is summarized. Crude estimates of bremsstrahlung and neutron generation appear to be adequate for planning purposes. Both theory and experiment show that radiation from induced activities in the structure and shield, not the air, limit access following long periods of operation. (8 figures, 1 table) (R.W.R.)

31632 (CERN–71-16(Vol.1 and 2), pp 915-23) DISPOSAL OF A 400-MeV SYNCHROCYCLOTRON AND A SUMMARY OF MONITORING DURING NORMAL OPERATION. Birchall, I. (Liverpool Univ. (England)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

A general discussion of the radiation hazards around the 400-MeV Liverpool Synchrocyclotron is given. Personnel monitoring and area radiation surveys are discussed. Finally, the dismantling and disposal of the machine are described. (R.W.R.)

31633 (CERN–71-16(Vol.1 and 2), pp 948-65) ENVIRONMENTAL RADIATION AND RADIOACTIVITY FROM THE CERN HIGH-ENERGY ACCELERATORS. Prantl, F. A.; Baarli, J. (European Organization for Nuclear Research, Geneva (Switzerland)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The results of measurements of stray radiation at several locations on the CERN site, together with measurements of radioactivity in air, precipitation, and effluent water leaving the CERN site, are presented. The site monitoring system is described. It is concluded from these measurements that the stray radiation contributes less than the natural background to 100 m from the accelerators or experiment rooms. Air, dust, and effluent water radioactivity originating from the accelerators and measured on the CERN site are barely detectable at a distance of about 350 m from the sources and represent a very small contribution to the environmental radioactivity of the Laboratory surroundings. Although soil radioactivity in the shielding materials near the accelerators shows relatively high levels in certain areas; the activity in the wash-out water from this soil is negligible. (5 figures) (R.W.R.)

31634 (CERN–71-16(Vol.1 and 2), pp 980-1009) RADIATION PROTECTION PROBLEMS IN THE DESIGN OF THE EUROPEAN 300-GeV ACCELERATOR. Goebel, K. (European Organization for Nuclear Research, Geneva (Switzerland)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The proposed CERN 300-GeV accelerator and radiation protection problems related to the site and design of the project are described. The philosophy used in estimating radiation protection parameters at 300 GeV and the resulting predictions for shielding, induced activity, and absorbed energy are given. It is clear that considerable funds are needed to guarantee safe operation of the new machine; in an effort to keep these costs low, the protection system will be made as flexible as possible. (11 figures, 6 tables) (R.W.R.)

31635 (CERN–71-16(Vol.1 and 2), pp 1050-71) RADIATION SAFETY PHILOSOPHY AND ITS IMPLEMENTATION AT NAL. Awschalom, M. (National Accelerator Lab., Batavia, Ill.).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The fundamentals of the radiation safety philosophy adopted at NAL are as follows: the proton beam losses shall be not greater than those which lead to tolerable exposure rates after the accelerator is shut down; the biological shielding will be just adequate, as determined by taking into account best estimates of beam loss based on the above principle and occupancy times of different areas during accelerator on and off conditions; and the dose limits to personnel are the maximum legal ones without the addition of "local" safety factors. Each person is responsible for his own safety and that of this subordinates. Expected beam losses were used to determine the shielding required. Beam dumps and low remanent activity concrete are discussed, along with various environmental considerations. The radiation safety program is described, including personnel training, interlocks, and instrumentation; results with a newly developed albedo-type neutron dosimeter are given. (5 figures, 1 table) (R.W.R.)

31636 (LA–4899) MEDIUM-ENERGY PHYSICS PROGRAM. Quarterly Status Report for the Period Ending January 31, 1972. Dunn, Eleanor (comp.) (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. 46p. Dep. NTIS.

Topics include engineering support, accelerator systems development, electronic instrumentation and computer systems, accelerator operations, experimental area, LAMPF facility construction, physics research, theoretical physics, practical applications of LAMPF and the LAMPF users group. (W.H.K.)

31637 LENINGRAD 1-GeV PROTON SYNCHROCYCLOTRON. Abrosimov, N. K.; Alkhazov, D. G.; Dmitriev, S. P.; (and others) (Ioffe Inst. of Physics and Tech., Leningrad. Scientific-Research Inst. of Electrophysical Apparatus, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1399-1404(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1769-75(Sep 1971).

The 1-GeV proton synchrocyclotron of the A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad is described. The parameters of the proton beam, the characteristics of the basic accelerator systems, the beam channels, and the layout of the synchrocyclotron are described. This accelerator has been operating successfully since 1970. (auth)

31638 ACCELERATION AND EXTRACTION OF A DEUTERON BEAM FROM THE SYNCHROPHASOTRON OF THE JOINT INSTITUTE FOR NUCLEAR RESEARCH. Baldin, A. M.; Beznogikh, Yu. D.; Zinov'ev, L. P.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 685-7(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 29-31(May-Jun 1971).

Work was carried out on the synchrophasotron of the Joint Institute for Nuclear Research for the purpose of improving the linear accelerator and the high-frequency system to allow the previously proposed mode of accelerating deuterons to the limiting momentum of 11 GeV/c to be implemented. The beam of accelerated deuterons was extracted from the synchrophasotron, and physical experiments were begun. (2 figures) (auth)

31639 HIGH ENERGY HEAVY IONS. Thomas, R. H. (Univ. of California, Berkeley). Phys. Bull. (London); 23: 143-7(Mar 1972).

Reasons for the intense interest in the use of heavy ions as projectiles, especially in cosmic ray research and radiobiology, are outlined. Modifications required on the Bevatron acceleration systems for heavy ion work are described including the ion source, the linac injector, the stripping foil, the synchrotron, the synchrotron rf system, the beam control system, and the particle extraction system. The first attempt to demonstrate the feasibility of acceleration of heavy ions in the Bevatron is reported. Deuterons were readily accelerated and extracted with an energy of 2.1 GeV/nucleon at 3.10^{10} (and subsequently 10^{11}) deuterons/pulse. Later, at the same energy α particles were extracted at 5.10^{9} particles/pulse and nitrogen ions at 2.10^{5} particles/pulse. At 250 MeV/nucleon α and nitrogen particles were extracted. The identification of the nitrogen ions is described and some of the experimental work carried out at each stage of the production of the extracted beams is given. (UK)

Auxiliaries and Components

Refer also to abstracts 31106, 31693, and 32590.

31640 (CERN-71-16(Vol.1 and 2), pp 282-99) SYNCHROCYCLOTRON SHIELD-LEAKAGE NEUTRON SPECTRA. Aleinikov, V. E.; Komochkov, M. M.; Tsovboon, V. I. (Joint Inst. for Nuclear Research, Dubna (USSR)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The variation of neutron flux as a function of maximum proton energy and shielding composition is discussed for 300- to 700-MeV proton accelerators. Methods for calculating the neutron energy spectrum in the shield and the formalism for converting from the neutron spectra-angular distribution function inside the semi-infinite shield to the spectral angular distribution function of shield-leakage neutrons are considered. Neutron fluxes outside the shield of the Dubna synchrocyclotron are shown. (5 figures, 3 tables) (R.W.R.)

31641 (CERN-71-16(Vol.1 and 2), pp 431-43) QUALITY FACTOR OF RADIATION AND DOSE EQUIVALENT BEHIND THE SHIELDING OF THE 70-GeV PROTON SYNCHROTRON. Golovachik, V. T.; Dmitrievskii, I. M.; Kuchinin, S. L.; Lebedev, V. N.; Lysak, Yu. D.; Rudakova, G. M.; Semenov, Yu. V.; Frolov, V. V.; Chimankov, M. N.; Shanin, A. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

A spherical proportional counter with tissue-equivalent walls was used to measure the dose equivalent of radiation behind the shielding of the 70-GeV proton synchrotron; a similar ionization chamber was used to measure the contribution of radiation with LET less than 3.5 keV/μ of tissue. Direct determination of quality factor and dose equivalent of mixed radiation was performed with the aid of a Rossi counter and a method based on measuring column recombination in an ionization chamber filled with a tissue-equivalent gas at high pressure. Typical distributions are shown. (4 figures, 2 tables) (R.W.R.)

31642 (CERN-71-16(Vol.1 and 2), pp 581-600) EXPERIMENT TO DETERMINE SHIELDING REQUIREMENTS FOR A MULTI-GeV ELECTRON SYNCHROTRON RING. Coleman, F. J.; Thomas, D. C.; Saxon, G. (Daresbury Nuclear Physics Lab. (England)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The problem of shielding requirements for a proposed 15- to 20-GeV electron synchrotron were investigated experimentally at the Daresbury Nuclear Physics Laboratory. Measurements were made at 2 and 4 GeV with NINA. Dose equivalent values and neutron spectra are presented at 4 GeV for the earth shielding over the roof and alongside the outer wall of the magnet ring. Values are also given for various positions along the accessible side of the thicker inner wall of the ring. For simplicity the radiation is divided into photons and neutrons. It was found that 4 meters of earth provided adequate shielding for the existing machine. Although there are some problems associated with extrapolation to 20 GeV, it may be deduced that, for a 20-GeV beam of 10^{12} electrons/s lost in a 0.1-radiation length target, the thickness of the transverse shield would need to be, at worst, 8 m to reduce the level to 0.5 mrem/h. The localized beam loss would be expected to be much lower than 10^{12} electrons/s except in the targeting/extraction region; therefore, 6 m of earth should be more than enough shielding for the parts of the ring that are not tunneled into the hillside. (6 figures, 8 tables) (R.W.R.)

31643 (CERN-71-16(Vol.1 and 2), pp 641-51) MUON SHIELDING CALCULATIONS: HETEROGENEOUS PASSIVE AND ACTIVE SHIELDS, APPLICATIONS TO EXPERIMENTAL BEAMS AND AREAS. Theriot, D.; Awschalom, M.; Lee, K. (National Accelerator Lab., Batavia, Ill.).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The new high-energy, high-intensity accelerators require massive amounts of shielding. A computer program was developed which allows the design of heterogeneous shields with voids and/or magnetic fields. Calculational details on the muon source term and muon transport are given. Results of some of the studies made on the design of heterogeneous shields are presented. Specific application to the design of shielding for a primary external proton beam target and for a specific experiment is discussed. (4 figures) (R.W.R.)

31644 (CERN-71-16(Vol.1 and 2), pp 652-77) NUMBERS AND SPECTRUM OF MUONS FROM PROTON-INDUCED EXTRANUCLEAR CASCADES IN SHIELDS. Barbier, M. (European Organization for Nuclear Research, Geneva (Switzerland)); Hunter, R. (Glasgow Univ. (Scotland). Dept. of Mathematics).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

A mathematical model for the build-up and decay of cascades produced in shields by very-high-energy incident particles is developed; as far as possible, the various quantities of interest, e.g., the energy of the incident beam, the shielding material, etc., are separated. Two basic phenomena determine the cascade, absorption of hadrons in the material and production of secondary particles by such interactions. An expression is found for the energy spectra of the various generations of secondaries. The development of the hadron shower along an axis is followed; and it is found that, when the nuclear interaction cross section is independent of energy, the dependence of the flux on the coordinate along the direction of flight in successive generations can be totally decoupled from the energy spectrum of each generation. A consequence of this theorem is that the energy spectrum of a population is the same throughout the shield—only the numbers in each population change with depth. Finally, the expression for the spectrum of muons arising from the decay of pions of a given generation is found. A particular example of a production spectrum to illustrate some of the results derived is given in the appendix. (9 figures) (R.W.R.)

31645 (CERN-71-16(Vol.1 and 2), pp 697-713) DESIGN OF PENETRATIONS IN HADRON SHIELDS. Gollon, P. J.; Awschalom, M. (National Accelerator Lab., Batavia, Ill.).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The problem of personnel and vehicle penetrations in accelerator radiation shielding is discussed. Calculating the neutron dose rate outside a penetration may be divided into two parts: establishing a reasonable neutron source location, intensity, and energy spectrum so that one may calculate the neutron dose entering the penetration and calculating the neutron flux and/or dose attenuation in the penetration itself. The neutron component of the hadron cascade is the most significant in terms of its ability to penetrate both the bulk shielding and the penetrations in that shielding. Neutron doses were calculated by using the code ZEUS ALB.5; the calculational method of the program and results obtained from it for long straight penetrations, multileg labyrinths of conventional and novel geometry, and curved penetrations are discussed. (13 figures) (R.W.R.)

31646 (CERN-71-16(Vol.1 and 2), pp 714-24) DOSE DISTRIBUTION OF FAST NEUTRONS IN CONCRETE LABYRINTHS AS A FUNCTION OF NEUTRON ENERGY AND GEOMETRY. Perret, C. S. (Schweizerisches Institut fuer Nuklearforschung, Zurich). (In German).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

Service tunnels through shielding at accelerators are usually built like labyrinths. Fast neutrons are the decisive radiation in the calculation of the dose distribution in such labyrinths. Since high-energy neutrons are not reflected in the tunnel bends, they are not transported farther down the labyrinth. The dose attenuation along the axis of the labyrinth was ascertained with a computer program. From a systematic variation of the neutron energy and the geometry, simple rules could be derived which make possible a quick graphical determination of the dose distribution. The results of the graphical method are compared with measurements of other authors. The greatest discrepancies occur in the bends, due to the finite extent of the measuring apparatus in the region of high dose gradient. (4 figures, 1 table) (R.W.R.)

31647 (CERN-71-16(Vol.1 and 2), pp 725-47) PROPAGATION OF NEUTRONS IN THE ACCESS TUNNEL TO A HIGH-ENERGY PROTON ACCELERATOR. de Sereville, B.; Tardy-Joubert, Ph. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). (In French).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

Attention has been called to the importance of localized weaknesses and leaks in shielding at multi-GeV synchrotrons. It was necessary to develop a predictive tool that permits the proposal and evaluation of geometries for small and large access tunnels with the view of assuring the functional homogeneity of the shield. The results of an experiment done at the CERN PS to verify the validity of the model to be described are reported. The characteristics of the Monte Carlo program used are given. Applications of this tool were made to the proposed 45-GeV French synchrotron, the 300-GeV synchrotron at CERN, and the NAL synchrotron. (7 figures) (R.W.R.)

31648 (JINR-P16-6314) ACTIVATION OF WATER COOLING THE SYNCHROCYCLOTRON UNITS. Komochkov, M. M.; Teterev, Yu. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

The content of gamma-emitting isotopes in water cooling the synchrocyclotron units is considered. The gamma-radiation field in the vicinity of cooling system tubes was measured. Evidence for various ways of water activation is given. (2 figures, 2 tables) (auth)

31649 (LYCEN-7180) STUDY OF THE INTERDIGITAL STRUCTURE (RADIOFREQUENCY CAVITY STRUCTURE) IN VIEW OF ITS UTILIZATION IN AN ION LINEAR ACCELERATOR. Voisin, Gilles (Lyon Univ. (France). Institut de Physique Nucleaire). Nov 1971. 82p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Lyon Univ. (France).

A theoretical formalism for the periodic structure is presented. The operating conditions of the interdigital structure are examined, and a method is proposed which enables the geometry of the accelerating cavity to be determined. The formalism presented enables direct account to be taken of the existence and relative positions of the tube supports in the drift tube structure and information to be obtained about the dispersive and topographic properties of the fields. The interdigital structure has a number of points in common with the structures of Sloan and Lawrence and of Alvarez and, in fact, has the advantages of both these structures. (France)

31650 (NP-19259) INFLUENCE OF ELECTRON CURRENTS IN SUPERCONDUCTING RESONATORS. Dammertz, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Nov 1971. 34p. (In German). Dep. NTIS (U. S. Sales Only).

Due to electrons inside a cavity the eigenfrequency and the Q value of the cavity will be changed. On the one hand, it is possible to obtain a fast change in the eigenfrequency by injecting electrons from the outside; on the other hand, the mode will be disturbed by unwanted electrons. These unwanted electrons may be caused, for example, by secondary emission. The influence of the electrons on the eigenfrequency and on the Q value is investigated. Furthermore, the conditions for the existence of resonant electron currents in a homogeneous electrical rf field are discussed. The extension of this type of multipactoring to deflectors shows good agreement with experiment. The possibility of changing the eigenfrequency by an electron current injected from the outside was examined for a cavity operated in the TM mode. With this method it is possible to obtain a fast change of the eigenfrequency within a small frequency range, but the strong dependence of the eigenfrequency and of the Q value on the field amplitude causes difficulties. (10 figures, 3 tables) (auth)

31651 (RPP/A-88) TOWARDS THE DESIGN OF SUPERCONDUCTING MAGNETS FOR A PROTON SYNCHROTRON. Coupland, J. H. (Rutherford High Energy Lab., Chilton (England)). Feb 1972. 12p. (CONF-700503-12). Dep. NTIS (U. S. Sales Only).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970).

Some of the design problems encountered in using superconducting magnets in a proton synchrotron for energies up to 1000 GeV are discussed. Formulas for calculating the complete flux pattern of a thick coil surrounded by an iron shield are given. Both theoretical and practical aspects of the design of possible coil windings are considered. Magnets must have fields around 60 kG with no more than 0.1% variation, and maintain their field quality despite thermal, vacuum, and magnetic stresses. (4 figures) (R.W.R.)

31652 (TRITA-EPP-71-7) TUNING OF A SIDE-COUPLED ELECTRON LINEAR ACCELERATOR STRUCTURE. Babic, H.; Sedlacek, M. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). May 1971. 40p. Dep. NTIS (U. S. Sales Only).

The procedure for tuning of an S-band linear accelerator structure of coupled resonators operating in the $\pi/2$ mode is described. It was found convenient to start the adjustment by measuring groups of three cavities (two accelerating and one coupling) followed by the adjustment of the whole structure. (auth) (Sweden)

31653 VACUUM SYSTEM OF THE LENINGRAD 1-GeV SYNCHROCYCLOTRON. Malyshev, I. F.; Peregud, V. I.; Popkovich, A. V.; Shalmanov, V. I. (Scientific-Research Inst. of Electrophysical Apparatus, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1420-2(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1793-6(Sep 1971).

The vacuum system of the synchrocyclotron designed for accelerating protons to 1 GeV is described. A limiting vacuum of $1 \cdot 10^{-6}$ torr is achieved in a volume of 35 m^3 at a leakage rate of $9 \cdot 10^{-3}$ liter · torr/sec with six oil pumps. The chamber pressure is $(3-4) \cdot 10^{-6}$ torr under operating conditions. The features of the vacuum system and the automatic system for liquid-hydrogen cooling of the traps in the vacuum system are discussed. (auth)

31654 RADIO-FREQUENCY SYSTEM OF THE LENINGRAD 1-GeV SYNCHROCYCLOTRON. Roife, I. M.; Seredenko, E. V. (Scientific-Research Inst. of Electrophysical Apparatus, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1423-9(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1797-1805(Sep 1971).

The basic design of the radio-frequency system of the synchrocyclotron is described. The operating features of the dee circuit viewed as an oscillating system with parameters distributed on a plane are presented. An equation is given for the equivalent inductance; this equation takes account of the connection of the tuner at the narrow part of the dee. The effect of tuner asymmetry is studied. The basic features of the tuner design are described. The possible excitation and suppression of parasitic oscillations are discussed. (auth)

31655 PASSAGE OF BEAMS OF HIGH ENERGY PARTICLES THROUGH THICK LAYERS OF MATTER. Barashenkov, V. S.; Sobolevskii, N. M.; Toneev, V. D. At. Energ. (USSR); 32: No. 3, 217-21(Mar 1972). (In Russian).

The absolute yield, spectral angular characteristics and spatial distribution of particles beyond a thick shield are calculated by the Monte Carlo method. The cascade-evaporation model is used to describe particle-nucleus interactions. A comparison between the theoretical calculations and experimental data shows that the method developed can be employed successfully in the design of radiation shielding. This method is applicable at primary energies up to several tens of GeV. (1 figure, 8 tables, 9 references) (auth)

31656 ELECTROMAGNET OF THE LENINGRAD 1-GeV SYNCHROCYCLOTRON. Gritskov, B. E.; Indyukov, N. N.; Klimov, A. V.; (and others) (Scientific-Research Inst. of Electrophysical Apparatus, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1405-9(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1776-80(Sep 1971).

The choice of the basic electromagnet elements is discussed. A procedure for optimizing cost is described. Data obtained from a study of models of the electromagnet are reported. The features of the magnet system and the excitation winding are described. The basic magnet characteristics are reported. (auth)

31657 EFFECT OF INTENSE STREAMS OF ACCELERATED PARTICLES ON PARAMETERS OF SUPERCONDUCTING TRAVELING- AND STANDING-WAVE RESONATORS. Didenko, A. N.; Fomenko, G. P. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 6, 1001-6(Jun 1971).

Translated from Radiotekh. Elektron.; 16: No. 6, 1017-23(Jun 1971).

Energy storage processes and the beam loading effect in superconducting traveling- and standing-wave resonators in linear accelerators are investigated. It is shown that traveling-wave resonators show considerable advantages over standing-wave resonators in accelerators operating under certain conditions. (auth)

31658 PULSED ION SOURCE PRODUCING PULSES OF NANOSECOND LENGTH. Anufrienko, V. B.; Devkin, B. V.; Moroka, V. I.; Sal'nikov, O. A. (Inst. of Physics and Power, Obninsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 705-8(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 46-9(May-Jun 1971).

A pulsed ion source which is mounted on the cascade generator of a KG-0.3 is described. Descriptions of the circuits and sections are presented. The results of a test are presented, and physics experiments carried out on the accelerator are described briefly. The parameters of the ion pulses on the accelerator target are as follows: pulse current 1 mA, repetition frequency 2 MHz, pulse width at the half-height 4 ns. The bunching system draws a power of 400 W. The accelerator operating time for physics experiments is 2000 h per year. (5 figures) (auth)

31659 HIGH-VOLTAGE SOURCE FOR 2-MeV ION AND ELECTRON ACCELERATORS. Al'bertinskii, V. I.; Kuritsyna, I. V.; Nikonov, O. F.; Ovchinnikov, O. B. (Scientific-Research Inst. of Electrophysical Equipment, Leningrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 702-4(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 43-6(May-Jun 1971).

A 12-stage symmetrical multiplication circuit equipped with a two-loop stabilization system was used as a high-voltage source. In carrying out debugging operations by means of a special procedure, the parasitic capacitances of the structure were determined; this allowed the correct choice of the magnitude of the compensating inductances and the achievement of a voltage of 2.5 MV for the unit. (3 figures, 1 table) (auth)

31660 INJECTOR OF A LINEAR ACCELERATOR FOR MULTIPLY CHARGED IONS (LUMZI-10). Revutskii, E. I.; Skoromnyi, G. M.; Markin, P. S.; (and others) (Physical-Technical Inst., Kharkov). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 695-8(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 38-41(May-Jun 1971).

The basic parameters of the injector of the LUMZI-10 are given. The injector is designed for the acceleration of pulsed beams of ions of various elements having an intensity of 10 to 15 mA with $A/q \leq 5$ up to an energy of 112 keV/nucleon. The sources used in the injector ensured that the following beams could be obtained: a beam of He ions having an intensity of 7.5 mA and a duration of 800 μsec for a relative content of the component $^4He^+$ equal to 70%, and a beam of Be ions having an intensity of 8 mA and a duration of 300 μsec for a relative content of the component Be^{2+} equal to 45%. The construction of the injector sections is described, and the optimal operating modes of the ion sources are presented. (3 figures) (auth)

31661 EXCITATION AND VOLTAGE REGULATION FOR A 95 MVA SURGE-POWER GENERATOR. Bayer, Karl-Heinz; Schlegel, Gerhard (Siemens AG, Erlangen, Ger.). Siemens Rev.; 39: No. 1, 8-11(Jan 1972).

The excitation and voltage regulation for the surge-power generator which supplies the power for the magnets of the 28 GeV proton synchrotron at CERN in Geneva are described. The highly accurate voltage regulation which is required and the reproducibility of the magnet pulse cycles are treated in particular detail and the excitation circuit is explained. (auth)

31662 NEW D.C. POWER SUPPLY SYSTEM FOR THE MAIN RING MAGNETS OF THE 28 GeV CERN PROTON SYNCHROTRON. Jahn, Karl (Siemens AG, Erlangen, Ger.); Rieger, Edmund; Steckmann, Ernst. Siemens Rev.; 39: No. 1, 11-17(Jan 1972).

The new d.c. power supply equipment for the main ring magnets of the CERN proton synchrotron is capable of delivering peak currents of 6.4 kA at voltages of up to 12 kV. Details are given of the circuit configuration, the static converter and the associated smoothing, protection and control equipment, supplemented by operation oscillograms. (auth)

31663 VIBRATION PROBLEMS IN THE DESIGN OF THE 95 MVA MOTOR-GENERATOR SET FOR THE 28 GeV PROTON SYNCHROTRON AT CERN. Geissler, Karl; Hoffmann, Hans (Siemens AG, Erlangen, Ger.). Siemens Rev.; 39: No. 1, 17-28(Jan 1972).

Pulsed excitation of the main ring magnets of the proton synchrotron produces peak torques of up to 1 MNm (100 mtf) in the motor-generator set. The vibrations had to be kept away from the magnet ring, and natural torsional vibrations set up in the shaft system reduced to below a certain limit. It was necessary to provide a resilient mounting arrangement and incorporate a torsional vibration damper in the shaft system of the set. The springs and damping elements were dimensioned by optimization methods and calculations made of the vibrations and forces occurring. Vibration measurements taken during commissioning showed the operating performance to be fully satisfactory and confirmed correctness of the calculations. (auth)

31664 FOUNDATIONS OF A 95 MVA MOTOR-GENERATOR SET FOR PULSED DUTY. Probst, Paul Heinz (Kraftwerk Union AG, Erlangen, Ger.). Siemens Rev.; 39: No. 1, 28-31 (Jan 1972).

The location of the motor-generator set close to the 28 GeV proton synchrotron at CERN in Geneva called for a foundation design that eliminates the transmission of all disturbing vibration energy to the main ring magnets. The requirements were met by mounting the foundation on helical springs and providing additional dampers. The design of the foundation and vibration systems are described. (auth)

31665 SEASONAL DEFORMATION OF 2-MILE STRAIGHT LINE. Spranza, Joseph J.; Nur, Amos M. (Stanford Univ., Calif.). J. Soil Mech. Found. Div., Amer. Soc. Civil Eng.; 97: No. SM12, 1623-34(Dec 1971). (SLAC-PUB-891).

Relative motions of parts of the Stanford Linear Accelerator housing were measured and corrected repeatedly between 1966 and 1971. The vertical motion shows a steady decline with time, whereas both vertical and horizontal motions have a periodic component of one cycle per year. Displacement is upward in winter and downward in summer, and is clearly correlated with rainfall and water level in nearby wells. Consequently, the observed displacements must be associated with local soil and rock properties, and are not due to tectonic stress around the San Andreas fault system. (auth)

31666 MODIFIED FLAT POLE FOR A STRONG-FOCUSING CHANNEL IN A LINEAR ION ACCELERATOR. Beznogikh, Yu. D.; Voevodin, M. A.; Zinov'ev, L. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 699-701(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 41-3(May-Jun 1971).

A modified flat pole having a projection of specified dimensions on the flat part of its profile was investigated. For specified relationships between the profile dimensions such a pole reduces practically to zero not only in the sixth but also the tenth harmonic of the field expansion. The modified flat pole allows the working radius of the lens aperture to be widened in comparison with a conventional flat pole without increasing the dimensions of the lens itself. (3 figures) (auth)

31667 PULSE CIRCUITRY. (to Texaco Development Corp.). British Patent 1,269,782. 6 Apr 1972. Priority date 21 Aug 1968, United States.

Circuitry is described for delivering high-amplitude voltage pulses at high repetition rates with each pulse having a relatively short pulse width and fast rise and decay times; a number of serially connected p–n–p and n–p–n transistors are used in the circuit. This circuitry is suitable for pulsing neutron generators such as those used in nuclear well logging systems. The circuitry was designed to dissipate a minimum amount of power. (7 figures) (R.W.R.)

Ion Sources, Injection, and Extraction

31668 (ANL/HEP-7034, pp 153-65) POLARIZED BEAMS. Marmer, G. (Argonne National Lab., Ill.). Apr 1970.

From Symposium on polarization at high energy; Argonne, Ill. (15 Apr 1970).

The problems of achieving a high-energy polarized proton beam and how these problems may be circumvented are discussed. The feasibility of having such a facility at the ZGS in the not-too-distant future is indicated. The following points are discussed in detail: polarized proton sources; depolarization in the linac; depolarization in the ZGS during acceleration, depolarization during extraction; and measurement of the proton polarization. (L.B.S.)

31669 (CERN-72-5) EXPERIMENTAL RESULTS ON A FAST-CYCLING PULSED HV POWER SUPPLY. Brueckner, A.; Plunser, A. (European Organization for Nuclear Research, Geneva (Switzerland)). 13 Mar 1972. 20p. Dep. NTIS (U. S. Sales Only).

This report describes a full-size realization of a fast-cycling power supply for recharging 20 times the one-bunch delay line of the full-aperture kicker (FAK) of the Proton Synchrotron. It will allow the bunch-by-bunch transfer at 10 GeV from the 28 GeV CERN Proton Synchrotron to the 300 GeV CERN Proton Synchrotron. The power supply is capable of charging a 35 nF capacity up to 60 kV. It represents an improved version of the first proposal, published in September 1970 and successfully tested on a model in 1971. The new supply offers higher performance (the repetition time is 22 μsec instead of 50 μsec) combined with higher reliability and full timing flexibility, all this at lower cost. It needs only 20% of the stored energy foreseen in the earlier proposal. This 20-pulse supply consists principally of 10 double-triggered glass-envelope triode-thyratrons, each discharging a double capacitor into the primary winding of a premagnetized ferrite-core power pulse transformer. There are no semiconductor diodes on the HV side of the supply, as their reliability remains to be demonstrated. Performance measurements were made on a 40 kV-CX1154 thyratron. (auth)

31670 (JINR-P9-6252) BEAM MONOCHROMATIZATION BY MEANS OF RESONATOR. Gersch, Hans-Ulrich (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

A method has been proposed to improve the energy spread of a pulsed accelerator beam by means of an ion-optical system consisting of an analyzer and a high-frequency resonator. The application of this method for monochromatization of a 40-MeV isochronous cyclotron beam to obtain the final energy spread $\Delta E/E \approx 2 \times 10^{-4}$ was studied. With this the available emittance of the primary beam should be as large as possible. The conditions obtained show the applicability of the method by using a resonator with the wave length $\lambda = 2\text{m}$ which oscillates in the first and third harmonic. (5 figures, 1 table) (auth)

31671 ELECTRON TRAPPING IN BETATRON ACCELERATION. Tulinova, N. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1441-3(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1820-4(Sep 1971).

Betatron operation is discussed at low and moderate injection currents (transition to collective trapping) for injection-pulse lengths comparable to the revolution period of the particles in the chamber. In the collective-trapping region the most important interaction is that between particles being injected and fields due to particles injected earlier. Mechanisms associated with the interaction of particles within a single revolution have a smaller, though not negligible, effect on the γ yield. (auth)

31672 INFLUENCE OF NONLINEAR RESONANCES ON BEAM DIMENSIONS IN 70 GeV IHEP ACCELERATOR. Gridasov, V. I.; Myznikov, K. P.; Chepegin, V. N. At. Energ. (USSR); 32: No. 1, 81-2(Jan 1972). (In Russian).

The discrepancy between observed and calculated emittance at the end of the IFVE accelerator was investigated. A graph of the dependence of the horizontal and vertical dimensions of the beam on the magnetic field of the accelerator shows that, after the minimum is reached (9000 Oersteds) with iron saturation, the beam dimensions in both planes increase. During acceleration on a desired radius, an increase in beam dimensions occurs at the end of the cycle, which is caused by the action of nonlinear resonances. (K.S.W.) (3 figures)

31673 EMITTANCE AND ADMITTANCE IN PARTICLE ACCELERATORS. Scarlat, F. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 22: No. 3, 299-309(1970). (In Rumanian).

Topics include emittance of the ion source, transmission channel admittance, and beam matching. (W.H.K.)

31674 BETATRON. Anan'ev, Lev Martemianovich; Pekker, Yakov Semenovich; Chakhlov, Vladimir Lukianovich; (and others) (to Tomskii Ordena Trudovogo Krasnogo Znameni Politekhnicheskii Institut Imeni SM Kirova). British Patent 1,268,868. 29 Mar 1972 Filed 8 Aug 1969.

Reference is made to magnetic induction electron accelerators (betatrons). In conventional betatrons the electron emissive filament is heated from an auxiliary transformer, and this increases the size and weight of the machine, limiting its field of application. In the machine described the filament is heated from a winding that makes use of the variable magnetic flux created by the betatron electromagnet. (UK)

31675 COMPUTER OPTIMIZATION OF A PULSED PROCESS. OPTIMIZATION OF THE NUMBER OF ACCELERATED PROTONS IN THE CERN SYNCHROTRON. Danneels, A. (CERN, Geneva). Rev. A; 13: No. 4, 125-37(1971). (In Dutch).

A classical hill-climbing method designed for the determination of extrema of mathematical functions is applied to the optimization of a multivariable system for which no mathematical model is available. It is shown how the extremum-seeking process can be accelerated. This has an obvious economical justification and can take into account a limited capacity of the available computer but is unfavorable from a rigorous mathematical point of view. A simple and probably original solution is also presented for the problem of protection against noise and stochastic signals which may corrupt the measured values. In the treated case, the task of the computer is to control the trajectories of the protons when they are injected in the synchrotron so as to minimize the number of lost protons. It is possible to startup the synchrotron by employing the described method. (auth)

31676 HIGH-CURRENT PULSED ELECTRON GUN BASED ON AN ELIT-1 ACCELERATOR. Danilychev, V. A.; Khodkevich, V. E. (Inst. of Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 837-8(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 157-8(May-Ju 1971).

The construction of an electron gun based on an ELIT-1 accelerator is proposed which allows pulsed electron currents of up to 1 kA having a current-pulse length of 10 ns to be obtained at an accelerating voltage of 1 MeV. (2 figures) (auth)

31677 IMPROVEMENT OF THE PARAMETERS OF THE EXTERNAL BEAM OF A CYCLOTRON BY MEANS OF A SLIT COLLIMATOR. Krasnov, N. N.; Ognev, A. A.; Ponomarev, A. A. (Inst. of Physics and Power, Obninsk,USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 692-4(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 35-7(May-Jun 1971).

A system consisting of a movable slit collimator situated in the gap between dees is described; calculated and experimental dependences of the basic characteristics of the extracted beam on the position and width of the collimator slit are given. (3 figures) (auth)

31678 SEPARATED ION BEAM SOURCE WITH ADJUSTABLE SEPARATION. Wahlin, Lars E. (to Colutron Corp.). U. S. Patent 3,649,862. 14 Mar 1972. Filed 1 May 1969.

An ion beam source which includes an ion source, ion accelerator and focusing system, and a velocity filter with a deflection plate pair is described. The velocity filter provides for dispersion of ions according to their charge, mass and velocity. The ion source includes a nonconducting barrel, a filament mounted in the barrel and an anode enclosing the barrel opening except for a source aperture. Filament current is arranged to provide an electron current to the anode, this electron current ionizes the charge material thus forming a plasma cloud for ejecting into the focusing and lens system, and then into a velocity filter causing separation of the ion beam. (auth)

Ion Optics and Field Calculations

31679 (JINR-P9-6272) ON THE CAPTURE FROM THE RING BEAM OF r = 30 cm AND ACCELERATION UP TO FINAL RADIUS OF THE MAXIMUM CURRENT IN THE JINR SYNCHROCYCLOTRON. Danilov, V. I.; Poluboyarova, P. A.; Safonov, A. N.; Feoktistov, B. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

Capture of particles from the ring beam of $r = 30$ cm into synchrocyclotron acceleration is considered. The capture time is about 60 μ s. The calculation shows that, in the magnetic field of the JINR synchrocyclotron from $r = 30$ cm up to the final radius, a charge of $0.12 \cdot 10^{-6}$ C/pulse can be stably accelerated, while in the presence of the rings (which increase the magnetic field decay) on the lids of vacuum chamber, the charge can be $0.24 \cdot 10^{-6}$ C/pulse. These charges give currents of 14 and 26 μ A, respectively, at the modulation frequency of 113 Hz. (3 figures, 1 table) (auth)

31680 DEFLECTION OF PARALLEL CHARGED-PARTICLE BEAMS BY A PLANE ELECTROSTATIC MIRROR. Kel'man, V. M.; Fedulina, L. V.; Yakushev, E. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1444-8(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1825-31(Sep 1971).

The electron-optical properties of a two-dimensional plane electrostatic mirror characterized by the fact that an incident parallel charged-particle beam remains (in the paraxial approximation) parallel after reflection are considered. It is shown that there are two types of electrostatic mirrors; these differ in the character of their trajectories. The cardinal points are determined for each type. The angular aberrations are investigated, and expressions are found for the aberration coefficients. The aberrations are fourth order in the direction parallel to the median plane and third order in the direction perpendicular to this plane. The general theory is applied to the case of two-electrode electrostatic mirrors, for which all the necessary parameters are calculated. (auth)

31681 PARAXIAL PROPERTIES AND ABERRATIONS OF A TWO-ELECTRODE CYLINDRICAL MIRROR. Kel'man, V. M.; Fedulina, L. V.; Yakushev, E. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1449-54(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1832-8(Sep 1971).

The electron-optical parameters of a two-electrode cylindrical mirror, including spherical aberration and the aberrations of oblique beams, are calculated. (auth)

31682 MAGNETIC FIELD OF THE LENINGRAD 1-GeV PROTON SYNCHROCYCLOTRON. Abrosimov, N. K.; Eliseev, V. A.; Petrov, I. A.; Ryabov, G. A.; Chernov, N. N. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1410-14(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1781-6(Sep 1971).

The distribution and parameters of the magnetic field of the synchrocyclotron at the A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, are discussed. The tolerances for the distribution parameters of the magnetic field are estimated. Methods of shaping the radial decay of the magnetic field and compensating the azimuthal inhomogeneities of the vertical and radial field components are described. The final results of shimming the synchrocyclotron magnet are given: The amplitude of the first harmonic of the vertical component and the mean radial component are less than $2 \cdot 10^{-4}$ of the basic field. The field decay in the central region of the magnet is augmented in order to improve vertical focusing. The shimming is checked, taking account of the deformation of the chamber top due to the vacuum. (auth)

31683 MEASUREMENT OF THE MAGNETIC FIELD IN THE LENINGRAD 1-GeV SYNCHROCYCLOTRON. Eliseev, V. A.; Ryabov, G. A.; Tkach, I. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1415-19(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1787-92(Sep 1971).

The procedure used in measuring the magnetic parameters of the 1-GeV synchrocyclotron of the Ioffe Physicotechnical Institute are discussed. The instrumentation system developed for this purpose is described; it consists of an automatic coordinate system with control and digital printout, a nuclear magnetometer with automatic frequency adjustment, a precision Hall magnetometer, and a device for measuring the position of the median surface. (auth)

31684 PROPAGATION OF HIGH-ENERGY ELECTRON BEAMS. Fargo, Victor. Stanford, Calif.; Stanford Univ. (1971). 191p. University Microfilms Order No. 71-11,547. Thesis.

The propagation of intense high-energy electron beams of up to 2.0 MeV electrons and of $\nu/\gamma \ll 1$ in a pulsed mode 30 to 50 ns in duration was studied. These beams were guided in metal-mesh-lined Lucite drift tubes of straight and bent geometry and with background air pressure of 0.02 to 760 torr. Their propagation characteristics were investigated through observation of beam behavior from time-integrated photography of the beam's generated visible light and measurements of beam front velocity, total energy transport, electron spectral distribution and beam's magnetic field. Results of this work showed that efficient propagation, energy transport, guiding, and control of $\nu/\gamma \ll 1$ intense relativistic electron beams can be accomplished over relatively long distances only at optimum transport residual gas pressures. The effect of an axial magnetic guide field on a relativistic beam of $\nu/\gamma \gg 1$, propagating in a narrow accelerating diode is also presented. Results of this work indicate that pronounced suppression of beam collapse in a diode can be achieved by axial magnetic fields with intensities much smaller than the beam's self-magnetic field. (TSS) (Diss. Abstr. Int., B)

31685 CW STANDING-WAVE LINACS AND TRANSVERSE BEAM BLOWUP. Aboul-Atta, O. A. (Univ. of Manitoba, Winnipeg). Can. J. Phys.; 50: No. 2, 110-5(15 Jan 1972).

The beam interaction with transverse magnetic (TM_{11}-like) modes in standing-wave linear accelerators leads to the phenomenon of beam blowup whenever the average beam current exceeds a critical value. Previous theories that estimate a lower bound for that threshold current neglect the interaction of the neighboring modes in the periodic structure. A more realistic estimate was developed that carefully includes the effect of the coupling on the damping mechanism and takes into consideration all factors influencing the system response. Developed results supply the designers with the various parameters that could be varied, should higher values than the previously mentioned threshold current be needed. The reported analysis takes care of a complete tank length of coupled cells with emphasis on the side-coupled structures for their distinct advantages in machines of high current capacity. The physics of the oscillation mechanism is cast in one final formulation with known transient solution. The external force function is made available for discussing the steady-state solution when the pulse frequency is a submultiple of the resonance frequency, which causes the off-centered beam to be deflected and usually puts one of the constraints on beam focusing. (auth) (UK)

Storage Rings

Refer also to abstract 31055.

31686 (BNL-16736) INTERSECTING STORAGE ACCELERATOR NOTES: VACUUM CHAMBER EDDY CURRENTS. Bittner, J. W. (Brookhaven National Lab., Upton, N. Y.). 24 Feb 1972. 6p. Dep. NTIS.

In order to reduce the power losses due to the beam induced rf currents in the vacuum chamber of ISABELLE, it was necessary to furnish the chamber with some kind of copper wall, either a thin film of copper, a few rf skin depths thick, about 0.1 mm, on a stainless steel tube, or a tube made completely of copper, perhaps about 1 mm thick. In any case, the resistivity of this copper at 4.5°K will be about 100 times lower than that normally encountered at room temperature. Therefore the effects of eddy currents induced by the slowly rising magnetic fields during the acceleration phase of the magnet cycle are estimated. (W.H.K.)

31687 (CERN-71-16(Vol.1 and 2), pp 748-72) RADIATION SAFETY IN THE DESIGN AND OPERATION OF THE CERN INTERSECTING STORAGE RINGS. Van de Voorde, M. H.; Middelkoop, W. C.; Rieben, P.; Routti, J. T. (European Organization for Nuclear Research, Geneva (Switzerland)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The radiation problems of the ISR resemble those of a proton synchrotron of comparable energy. The multiple operation modes, the complexity of the physical layout, the fact that the colliding beam experiments are done in the ISR tunnel, and the intensities of the stacked beams, however, impose some special requirements. Questions of radiation shielding, radiation hazards, and radiation damage characteristic to the ISR are discussed. Beam losses due to gas scattering and various machine operations (injection, stacking, scraping, ejection, and dumping) are estimated. The design criteria and methods for the main shielding are described. The personnel protection system, including the controlled access system and restricted zones, is discussed. The questions of material selection and dosimetry are reviewed, and the experiences of early operation are summarized. (5 figures, 4 tables) (R.W.R.)

31688 (CERN-71-16(Vol.1 and 2), pp 924-34) RADIATION CONTROL AROUND THE ADONE STORAGE RING AT FRASCATI. Pelliccioni, M.; Roccella, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). (In French).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

During injection the health physics problems at a storage ring are practically the same as those at a conventional accelerator. During work with the accumulated beams, however, it is necessary for the experimenters to be inside the ring with their equipment; they are thus exposed to the risks of radiation due to losses that the beams undergo through bremsstrahlung on the particles of the residual gas. To these risks are added those due to accidental losses of the beams. Experimenters near the place where the particles are lost are thus subject to overexposure. The risks of radiation exposure in these two cases, normal losses and accidental losses, were studied, and the results of these measurements are reported. The measurements were made with thermoluminescent dosimeters at the straight sections of the machine, where losses are expected to be the most important. It was found that significant doses are received only in a very limited zone near the machine; indeed, in none of the numerous measurements made were any appreciable doses detected at distances of more than 2 or 3 meters. The risks are thus restricted to a very narrow region, and a large area inside the ring can be considered reasonably safe. (6 figures) (R.W.R.)

31689 (CERN-71-16(Vol.1 and 2), pp 935-47) PRELIMINARY HEALTH PHYSICS EXPERIENCE WITH THE OPERATION OF THE CERN INTERSECTING STORAGE RINGS. Hoefert, M. (European Organization for Nuclear Research, Geneva (Switzerland)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The transfer tunnels and storage rings at the CERN ISR are briefly described. During test runs radiation levels in experiment areas and outside the main shield are barely detectable and should be zero once a stacked beam is circulating without losses. The induced radioactivity stays mainly concentrated in the internal beam dumps, and it is in this area that a real danger to personnel exists. A radiation monitor system installed in the interior of the ISR will assist in detecting unexpected proton loss points by their level of induced radioactivity. After empirical calibration the system is able to give quantitative results on dose rates at 40 cm from the ISR rings. (5 figures) (R.W.R.)

31690 (LNF-72/16) USE OF TOROIDAL MAGNETIC FIELD FOR EXPERIMENTATION WITH STORAGE RINGS. EVALUATION FOR ADONE. Spillantini, P. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 18 Feb 1972. 22p. Dep. NTIS (U. S. Sales Only).

In order to overcome difficulties with most magnets so far proposed for use with storage rings (the magnetic and mechanical linking with the beams, the loss of the simple geometry of the event, the return of the field flux, the limits to the maximum value of the field and the solid-angle accepted), a type of magnet is discussed with no external flux and with no field or derivative of the field at the axis. Although the uniformity of the field inside the coils is lost, such uniformity is of little importance provided that the dependence of the field on the spatial coordinates be regular and not too strong. Possible solutions for Adone with such a magnet with toroidal field produced by aluminum coils and superconducting wires are presented. Different systems for the detection of trajectory curvature are considered; these systems being about some simplification in the solutions obtained. (25 figures, 3 tables) (R.W.R.)

31691 MULTIPLE-BUNCH PHASE STABILITY IN STORAGE RINGS. Karliner, M. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1430-4(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1806-11(Sep 1971).

The stability of multiple-bunch phase motion in relativistic storage rings is investigated taking account of the electromagnetic interaction between the beam and the external system. Stability conditions are obtained for the typical case of identical bunches, the number of bunches being equal to a multiple of the radiofrequency. The stability criteria are given in the form of a system of inequalities, each of which guarantees stability of a corresponding symmetric mode. The differences between the multiple-bunch case and the single-bunch case are discussed. The growth rate for symmetric modes is given. (auth)

Experimental Facilities

Refer also to abstracts 32004 and 32415.

31692 (ANL/HEP-7034, pp 147-52) POLARIZED TARGETS: RECENT ADVANCES. Hill, D. (Argonne National Lab., Ill.). Apr 1970.

From Symposium on polarization at high energy; Argonne, Ill. (15 Apr 1970).

A summary is given of some of the new techniques in polarized proton targetry, particularly with respect to the new hydrocarbon materials for the targets. Some of the properties of butanol and glycol are listed with the corresponding properties of LMN for comparison. The new ammonia-glycerol mixture is also listed. (L.B.S.)

31693 (CERN-71-16(Vol.1 and 2), pp 678-96) PROGRAM FOR CALCULATING MUON FLUX IN AN ACTUAL CONFIGURATION. Bertel, E.; de Sereville, B. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). (In French).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The production and propagation of muons in matter are phenomena that can be described, with certain simplifying assumptions, by analytic formulas. A computer program was written to evaluate the muon flux in some actual geometical configurations, and it was applied to different accelerator projects. Studies of the shield thicknesses necessary to keep the dose around the main ring, the beam transport tunnels, and the external target stations below the maximum permissible limit were made in this way. The proposed shielding for the French project J 45 B and for the west experiment area of project B of the CERN 300-GeV proton synchrotron are described. The program, which does not take much computer time, gives a good estimate of the muon flux produced by high-energy protons, with the effects of magnetic fields and shields taken into account. (6 figures) (R.W.R.)

31694 (CERN-71-16(Vol.1 and 2), pp 814-35) COMPARISON OF MEASUREMENTS AND CALCULATIONS FOR A 29.4-GeV/c STEEL BEAMSTOP. Van Ginneken, A.; Awschalom, M.; Borak, T. (National Accelerator Lab., Batavia, Ill.).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The results of a Monte Carlo calculation (with allowance for voids in the shielding) are compared with measured values at 29.4 GeV/c for an experiment in a steel beam stop and one using a side shield geometry. The code almost uniformly underestimates the data from the former experiment, but agreement is better for the latter case. The code was then used to calculate star densities for a target in an experimental cave and for a long decay tunnel at NAL; these results are compared with those of other authors. (6 figures) (R.W.R.)

31695 (LA-4916) MICROPROGRAMMED BRANCH DRIVER (MBD) FOR A PDP-11 COMPUTER. Biswell, Lavon R.; Rajala, Robert E. (Los Alamos Scientific Lab., N. Mex.). Apr 1972. Contract W-7405-eng-36. 13p. Dep. NTIS.

A microprogrammed branch driver (MBD) is the interface between a Digital Equipment Corporation (DEC) PDP-11 computer and a multicrate CAMAC system. This unit is a multiple, direct memory access (DMA) channel branch driver. The requirements for an MBD are discussed in the introduction, and stem from a Los Alamos Scientific Laboratory (LASL) study group report on the design of the Los Alamos Meson Physics Facility (LAMPF) data-acquisition system. Because of the desire for a standard system, the types of experiments and data rates, and the varying complexity of data-acquisition systems, it was decided that a microprogrammable, multiple DMA channel branch driver was required. Basic specifications and capabilities of the MBD are discussed and a block-diagram-type operation is presented, which includes the modes, registers, priority structure, interrupts, DMA channels, instruction set, branch driver, and initialization and run procedures. Modes of operation and design options are given, and the standard logic used to fabricate the MBD, the hardware system, is discussed. Included are diagnostic and standard driver routines, and a program example. (auth)

31696 (NP-19264) STUDY OF THE CONSTRUCTION OF A HIGH-RESOLUTION SPECTROMETER FOR INVESTIGATION OF PROTON-INDUCED NUCLEAR REACTIONS IN A PLANNED SUPERCONDUCTING LINEAR ACCELERATOR IN KARLSRUHE AND IN AN ISOCHRON RING ACCELERATOR IN ZURICH. Koch, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Apr 1971. 17p. (In German). Dep. NTIS (U. S. Sales Only).

For the examination of proton induced nuclear reactions in the region of medium energy physics, proton spectrometers with an excellent energy resolution are required. A proposal is made for the construction of such a spectrometer for the planned superconducting linac in Karlsruhe and the isochron-cyclotron in Zürich (SIN) taking into account the experiences and calculations for a similar project in Los Alamos. Absolute energy and energy loss configurations are discussed. It is shown that no beams of highest energy purity are needed and a beam energy uncertainty of some MeV can be admitted. A qualitative estimate for the costs of the proposed systems in Karlsruhe and Zürich is given. (auth)

31697 (UCSB-34-P-135-15) TAGGED PHOTON BEAMS FOR VERY HIGH ENERGY. Morrison, R. J.; Caldwell, D. O.; Elings, V. B.; Hesse, W. P.; Murphy, F. V.; Worster, B. W. (California Univ., Santa Barbara. Dept. of Physics); Yount, D. E.; Murray, J. J. (Stanford Linear Accelerator Center, Calif.). 1970. 5p. (CONF-700902-8). Dep. NTIS.

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The need for tagged photon beams is discussed; and a system used at SLAC, in which only 0.3% of the tagging signals were not accompanied by proper photons, is described. (2 figures) (R.W.R.)

31698 CHANNEL SYSTEM FOR NEGATIVE PARTICLES WITH MOMENTA UP TO 40 GeV/c. Grachev, M. I.; Gubrienko, K. I.; Eremenko, E. V.; (and others). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1435-40(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1812-19(Sep 1971).

A channel system is described for negative particles with momenta up to 40 GeV/c produced in the accelerator of the Institute for High-Energy Physics. A procedure is described for studying the characteristics of particle beams in these channels, and the basic parameters of the channels are presented. (auth)

31699 FORMATION OF BEAMS OF POSITIVE PARTICLES HAVING MOMENTS OF 25 TO 70 GeV/c FROM THE INTERNAL TARGET OF THE IFVE ACCELERATOR. Golovnya, N. I.; Grachev, M. I.; Gubrienko, K. I.; (and others). At. Energ. (USSR); 32: No. 3, 244-7(Mar 1972). (In Russian).

The output of positive particles from the Serpukhov accelerator was inhibited by the reverse action of the diffused field of the accelerator. Using magnetic screens and a three-target system, a beam of positive particles (protons, π^+-mesons, K^+-mesons, and deuterons) could be formed in one magneto-optic channel in a wide range of momenta (25 to 70 GeV/c) for a fixed proton energy in the 70 GeV accelerator. The effect of target placement on the momenta of the charged particles was studied, both with and without magnetic screens. For given momenta the intensity of the beam, and the relative particle content of the beam was determined. (K.S.W.)

31700 150-cm LIQUID-HYDROGEN TARGET. Golovanov, L. B. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 715-16(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 55-6(May-Jun 1971).

The construction of a liquid-hydrogen target is described. The diameter of the inner vessel of the target is 200 mm, and its length is 1.5 m. Hemispherical stainless steel caps 140 μ thick are mounted on the end faces of the target. The target is insulated with multilayer insulation 90 mm thick. In order to reduce the heat influx the shields are cooled by evaporating hydrogen. The discharge of hydrogen from the target is 0.7 liters/h. (2 figures) (auth)

31701 50-cm LIQUID-HYDROGEN TARGET WITH MYLAR WINDOWS. Borzunov, Yu. T.; Golovanov, L. B.; Mazarskii, V. L.; Tsviev, A. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 712-14(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 52-4(May-Jun 1971).

The construction of a 50-cm liquid-hydrogen target with Mylar windows is described. The diameter of the windows is 100 mm. The capacity of the target is 7.7 liters. The scheme for feeding the target from a supplementary vessel is shown. Target versions are presented for various physical experiments. (2 figures) (auth)

31702 LINAC LUE-25 AS AN ISOTROPIC NEUTRON SOURCE. Kovalev, V. P.; Kharin, V. P.; Gordeev, V. V.; Isaev, V. I. At. Energ. (USSR); 32: No. 2, 173-5(Feb 1972). (In Russian).

For the purpose of producing an isotropic neutron source investigations were conducted on the yields and angular distribution of photoneutrons from Pb targets of different shapes bombarded with 23-MeV electrons in a linear accelerator. The yield of photoneutrons was measured by means of a 30-cm paraffin sphere which served as a moderator with In foils placed at the center of the sphere. The most practical isotropic neutron source proved to be a 60-mm diameter Pb sphere with a 20-mm well used in conjunction with 23-MeV electrons. (2 figures) (K.S.W.)

31703 CALCULATION OF THE D–T NEUTRON YIELD DURING PERIODIC REPLENISHMENT OF A TRITIUM TARGET. Tustanovskii, V. T. At. Energ. (USSR); 32: No. 2, 175-7(Feb 1972). (In Russian).

A borrowed formula which characterizes the D–T neutron yield during periodic replenishment of a tritium target is employed in an analysis of the effect of several cycles, where a single cycle consists of bombarding a target with a neutron beam and subsequent replenishment of the target with tritium. A study of the change in T concentration as a function of the number of cycles showed that a constant T concentration was eventually achieved. (3 figures) (K.S.W.)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

31704 VACUUM-ULTRAVIOLET SPECTROSCOPY. Zaidel, A. N.; Shreider, E. Ya. Ann Arbor, Mich.; Ann Arbor-Humphrey Science Publishers, Inc. (1970). 405p. $22.50. International Scholarly Book Services, Inc., Portland, Oreg.

Translation of Spektroskopiya Vakuumnogo Ul'trafioleta by Z. Lerman.

The following chapters are included: (1) radiant energy sources, (2) optical materials, (3) spectral instruments, (4) detectors for vacuum uv, (5) wavelength measurement, (6) energy measurements in vacuum uv, (7) absorption spectra in vacuum uv, (8) determination of atomic constants from measurements in vacuum uv, (9) plasma diagnostics, (10) the short-wave radiation of the sun, and (11) spectroscopic analysis in the vacuum uv. (M.O.W.)

Cosmic Radiation

Refer also to abstracts 30654, 31152, 31851, 31852, 31932, 32025–32027, 32593, and 32595.

31705 (CERN–71-16(Vol.1 and 2), pp 484-91) COSMIC RADIATION MEASUREMENTS USING NUCLEAR EMULSIONS ON BOARD THE ZOND-5 AND 7 AUTOMATIC STATIONS. Blashkovskii, V. A.; Volkov, A. A.; Ostroumov, V. I.; Smiren[illegible] . N. (Ministerstvo Zdravookhraneniya SSSR, Moscow. Institut Mediko-Biologicheskikh Problem).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

Results of measurements of fluxes and differential energy spectra of cosmic protons as well as spectra of neutron-produced recoil protons are presented. The differential energy spectra were assessed by different techniques in the following ranges: 1 to 15 MeV; 20 to 100 MeV; and 0.2 to 10 GeV. (L.M.T.)

31706 (INR–1345) RADIAL DENSITY DISTRIBUTION OF THE FLUX OF CHARGED PARTICLES IN EXTENSIVE AIR SHOWERS. Gawin, Jerzy; Hibner, Juliusz; Kempa, Janusz; Piotrowska, Zofia (Institute of Nuclear Research, Warsaw (Poland)). 1971. 24p. (In Polish). Dep. NTIS (U. S. Sales Only).

Three methods were used to characterize the radial distribution of the charged-particle flux in EAS. Two methods show that in the central part of a shower, the value of the age parameter s is smaller than the generally accepted value ($s = 1.25$), and is, in fact, about 1.0 to 1.1. The third method shows the value of the s parameter to be $s = 1.0$ to 1.1 for the central part, and $\bar{s} = 1.25$ for the far area of the shower; the mean value for all distances is about $\bar{s} = 1.25$. (auth)

31707 COSMIC-RAY SOURCE AND LOCAL INTERSTELLAR SPECTRA DEDUCED FROM THE ISOTOPES OF HYDROGEN AND HELIUM. Comstock, G. M.; Hsieh, K. C.; Simpson, J. A. (Univ. of Chicago). Astrophys. J.; 173: No. 3, 691-709(1 May 1972).

From the experimental information now available on the quartet of isotopes ^{1}H, ^{2}H, ^{3}He, and ^{4}He, and recognizing that, except for small contributions from C, N, and O nuclei, a closed generic relationship exists within the quartet, one can obtain a self-consistent model for cosmic-ray hydrogen and helium propagation from the sources in the Galaxy to the orbit of Earth. The only adjustable parameters for the quartet are: (1) the shape of the energy spectra of ^{1}H and ^{4}He at the time of source injection, (2) the distribution of particle path lengths in interstellar space, and (3) the solar modulation parameters. It was found that: (1) the allowed form of the source differential spectra of the ^{1}H and ^{4}He nuclei is dominated by a power law in total energy ($W^{-\gamma}$) with $\gamma = 2.6$ (other forms of source spectra currently thought to be possible are eliminated); (2) the local interstellar ^{1}H and ^{4}He spectra are relatively flat at low energies—perhaps even decreasing for energies $\lesssim$200 MeV per nucleon; (3) the leakage mean free path for interstellar propagation is 4(+1, −2) g cm^{-2}; and (4) energy-loss processes definitely occur during solar modulation. . Also discussed are the implications of this self-consistent model, among the most important of which are that (1) a source spectrum with a single index cannot contribute to the heating of interstellar gas clouds by cosmic rays, and (2) cosmic-ray hydrogen has a lifetime similar to the other H and He isotopes, namely, $\sim 3 \times 10^6$ years. (auth)

31708 CHEMICAL COMPOSITION OF COSMIC RAYS. I. Aller, Lawrence H. (Univ. of California, Los Angeles). Sky Telesc.; 43: No. 5, 285-7(May 1972).

A brief report is given on the cosmic-ray conference held at Hobart, Tasmania. Topics reviewed include galactic cosmic rays, the electron component, and general features of galactic cosmic-ray abundances. (W.D.M.)

31709 COMMENTS ON THE IONOSPHERIC DETECTION OF COSMIC X-RAY PHENOMENA. Baird, G. A.; Francey, R. J. (Simon Fraser Univ., Burnaby, Can.). J. Geophys. Res.; 77: No. 10, 1966-70(1 Apr 1972).

Detection of cosmic x-ray phenomena in the ionosphere from effects observed is discussed. Acceptance of any one of the reported effects limits other ionizing influences and the nighttime electron density to the lower range of currently reported values. The nova x-ray sources provide a unique tool for verification, since their onset is considerably faster than the time scale of seasonal effects. Acceptance of electron precipitation as a dominating ionizing influence at L values greater than about 2, but not below 2, would explain many of the conflicts in the vlf data. The temporal nature of some of the equatorial NPA's suggest a search for coincidence with impulsive astronomical events, in particular supernova collapse and gravitational events. Svennesson et al., J. Atmos. Terres. Phys., 34: 49 (1972) reported extensive ionospheric data showing vlf phase anomalies due to Scorpius XR-1, Centaurus XR-2 and XR-4. While their explanation of null results over some paths in terms of unsuitably low propagation frequencies is undoubtedly relevant, it is striking that all of their positive reports correspond to paths with midpoints at $L < 1.7$, and support the authors' view of the important masking effect of precipitated electrons at higher L values. (23 references). (J.C.W.)

31710 ^{40}Ar–^{39}Ar AGE AND COSMIC-RAY IRRADIATION HISTORY OF THE APOLLO 15 ANORTHOSITE, 15415. Turner, G. (Univ. of Sheffield, Eng.). Earth Planet. Sci. Lett.; 14: No. 2, 169-75(Mar 1972).

The ^{40}Ar–^{39}Ar method of age determination was applied to the Apollo 15 anorthosite sample, 15415. Release of argon from the most retentive crystal sites indicated an age of (4.05 ± 0.15) aeons. On the assumption that the anorthosite represents pre-Imbrian crustal material which may have been reheated in the Imbrium impact, this age was interpreted as representing only a lower limit to the original crystallization age and also an upper limit to the time of formation of the Imbrium basin. 15415 shows evidence of relatively recent ^{40}Ar loss. A comparison of ^{40}Ar–^{38}Ar and ^{38}Ar–^{37}Ar release patterns indicated that the radiogenic ^{40}Ar loss occurred before cosmogenic ^{38}Ar accumulated, and therefore probably as a result of recent impact heating rather than solar heating. The cosmic ray exposure age of 15415 is 112 my. (auth)

31711 U, Th, Pb, AND REE ABUNDANCES AND ^{207}Pb/^{206}Pb AGES OF INDIVIDUAL MINERALS IN RETURNED LUNAR MATERIAL BY ION MICROPROBE MASS ANALYSIS. Andersen, C. A.; Hinthorne, J. R. (Hasler Research Center, Goleta, Calif.). Earth Planet. Sci. Lett.; 14: No. 2, 195–200(Mar 1972).

Ion microprobe analyses of Apollo 11, 12, and 14 material have shown that U, Th, Pb, and REE are concentrated in accessory minerals such as apatite, whitlockite, zircon, baddeleyite, zirkelite, and tranquillityite. Th/U ratios are found to vary by over a factor of 40 in these minerals. K, Ba, Rb, and Sr have been localized in a K rich, U and Th poor glass phase that is commonly associated with the U and Th bearing accessory minerals. Li is observed to be fairly evenly distributed between the various accessory phases. The phosphates have been found to have REE abundance patterns (normalized to the chondrite abundances) that are fairly flat, while the Zr bearing minerals have patterns that rise steeply, by factors of ten or more, from La to Gd. All the accessory minerals have large negative Eu anomalies. Radiometric age dates (^{207}Pb/^{206}Pb) of the individual U and Th bearing minerals compare favorably with the ^{207}Pb/^{206}Pb age of the bulk rocks. (auth)

31712 MASS FRACTIONATION AND UNIFIED THEORY OF XENON ISOTOPE ANOMALIES. Narra, Rama Kotesware Rao. Fayetteville, Ark., Univ. of Arkansas (1971). 95p. University Microfilms Order No. 72-10,213.

Thesis.

The abundance and isotopic composition of xenon and krypton in Kapoeta Light were determined by performing temperature-release experiments. The role of mass fractionation in explaining the carbonaceous chondrites puzzle is discussed. It is shown that the xenon anomalies in terrestrial samples can be accounted for, in large part, in terms of mass fractionation. The effect of mass fractionation was identified in achondrites; this in no way affects the earlier established components. It was postulated that it is not necessary to consider that xenon and krypton fractionate in opposite directions. The observed behavior can be explained on the basis that the ratio of solar to planetary components does not remain the same for all rare gases. A unified model, which considers that the xenon observed in meteorites, terrestrial and lunar samples is a mixture of five components (solar, planetary, radiogenic, fission, and spallation) is proposed to account for the xenon anomalies. (Diss. Abstr. Int., B)

31713 SCATTERING OF HIGH-ENERGY COSMIC RAYS. Wentzel, Donat G. (Univ. of Maryland, College Park). Astrophys. Lett.; 10: No. 4, 167-70(Apr 1972).

When cosmic rays stream through highly ionized interstellar regions, they generate hydromagnetic waves that scatter the cosmic rays until the cosmic-ray streaming speed is less than (about) two times the Alfven speed, independent of the cosmic-ray energy. Confinement to the Galaxy of the 100 GeV cosmic rays, at their observed low streaming rates, requires a rather large scattering region, possibly the galactic corona or many nebulae like the Gum Nebula. (auth)

31714 SEARCH FOR ANTIMATTER IN PRIMARY COSMIC RAYS. Buffington, A.; Smith, L. H.; Smoot, G. F.; Alvarez, L. W.; Wahlig, M. A. (Univ. of California, Berkeley). Nature (London); 236: No. 5346, 335-8(14 Apr 1972).

A new upper limit on the amount of antimatter in primary cosmic rays has been established. The limits are considerably lower than those for any previous experiment. (auth)

31715 SOLAR MODULATION AND THE CHEMICAL COMPOSITION OF THE COSMIC RADIATION. Waddington, C. J. (Univ. of Minnesota, Minneapolis). Nature (London); 236: No. 5347, 391-2(21 Apr 1972).

It is stated that the intensity variations of the cosmic radiation during the solar cycle can be simulated by assuming a heliocentric decelerating potential applied to the particles arriving from interstellar space, and that experimental and theoretical understanding of the process of solar modulation has recently improved. It seems that a full treatment of the diffusive–convective motions of the particles in the radially expanding solar wind results in an energy loss by the individual particles that can, on an average, be treated as analogous to the effects of a potential, except for particles of low energies ($\leq$100 MeV). An experimental test is proposed of the validity of this model and conflicting results in the literature may be reconcilable when the effects of energy loss are taken into account. The main issue is the effect of time-variable energy losses on the composition of the cosmic-ray nuclei. Many of the elements observed in the cosmic radiation are believed not to have had any significant abundance at the sources, but to be the consequence of fragmentation processes occurring during the passage of heavier nuclei through interstellar matter. If these fragmentation processes are energy-dependent, the observed abundances of the secondary nuclei will depend on the energy at which they are produced, and if the modulation process results in an energy loss between the interstellar energy and the observation energy, the composition will depend on the degree of modulation. Consideration is given to the nuclides of Li, Be, B, F, Mn, Cr, V, Ti, Sc, Ca, K, Ar, and Cl. (UK)

31716 PROCEEDINGS OF THE 11th INTERNATIONAL CONFERENCE ON COSMIC RAYS. VOLUME 1. ORIGIN AND GALACTIC PHENOMENA. Conference Held at Budapest, August 25–September 4, 1969. Somogyi, A. (ed.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 1-571(1970). (CONF-690814-(Vol.1)).

Separate abstracts were prepared for 86 of the 89 papers included. Three papers were previously abstracted; see NSA 23: 51264 and 24: 23829 and 28768. Volume II (solar cosmic rays), volume III (interactions above 50 GeV), and volume IV (muons and neutrinos) will be included in subsequent issues of NSA. (W.D.M.)

For abstracts of individual papers see: 31100, 31717–31793, and 31849–31856.

31717 SOME ASPECTS OF THE THEORY OF COSMIC-RAY ORIGIN. Ginzburg, V. L.; Syrovatskii, S. I. (Lebedev Inst. of Physics, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 9-16(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Several questions more fully investigated since the last conference (Canada, 1967) are discussed. The main questions are: (1) metagalactic cosmic rays (new estimates which follow from data of x-ray and γ astronomy); (2) charge composition of cosmic rays (new data and calculations); (3) spectra of galactic electrons and radio emission (comparison of data and calculation); (4) galactic sources of cosmic rays (supernovae, pulsars). (auth)

31718 ACCELERATION OF SOLAR AND GALACTIC COSMIC RAYS. Syrovatskii, S. I. (Lebedev Inst. of Physics, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 17-21(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The acceleration of cosmic and subcosmic rays is considered as a mode of dissipation of the macroscopic energy of the astrophysical plasma. It is pointed out that the usually considered thermal injection is very selective with respect to charge and mass of accelerated particles and in general does not represent the observed composition of cosmic rays. So cumulative injection and acceleration is assumed—a mechanism acting near zero (neutral) lines of the magnetic field. This mechanism accelerates all the particles in a small part of the plasma volume to the same rigidity. The maximum energy of particles accelerated by this mechanism may be more than 10^{20} eV for pulsars. So it is assumed that the whole observed cosmic-ray spectrum is produced in the Galaxy. (auth)

31719 STATISTICAL MECHANICS OF SUPERNOVAE. Jones, F. C. (Goddard Space Flight Center, Greenbelt, Md.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 23-9(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

In most treatments of the supernova origin theory of cosmic rays, average values of such observables as cosmic-ray flux, bulk-streaming velocity, total energy, etc., are calculated (or estimated) and compared with observation to determine the parameters of the theory. Since supernova explosions are essentially statistical events the question arises as to whether or not the observed values have any simple relationship to average values: in other words are fluctuations important? To investigate this question it was considered that the variables describing the supernova injection event (position, time, etc.) are random variables and that our Galaxy is a sample from an ensemble of galaxies. In this manner one can, in principle, calculate all higher moments of the cosmic-ray observables. It turns out that an important parameter may be derived for any particular model of cosmic-ray transport. If a single supernova event fills an effective volume V_{eff} with cosmic rays for a time τ_c and there are n supernova events per unit time per unit volume on the average, the quantity $\langle N\rangle = n\tau_c V_{eff}$ becomes essentially an inverse "discreteness parameter" in the sense that when it is large fluctuations are relatively unimportant, but when it is small fluctuations can dominate the situation. For currently considered models of the Galaxy the situation appears to be borderline. (auth)

31720 EVIDENCE FOR A POINT SOURCE OF HIGH-ENERGY COSMIC GAMMA RAYS. Frye, G. M. Jr. (Case Western Reserve Univ., Cleveland); Staib, J. A.; Zych, A. D.; (and others). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 31-4(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Evidence for the detection of cosmic gamma radiation above 50 MeV from a point source in Sagittarius is reported. (auth)

31721 SEARCH FOR SHORT PULSES OF ENERGETIC PHOTONS FROM SUPERNOVAE USING THE ATMOSPHERIC FLUORESCENCE. Oegelman, H.; Bertsch, D. (Goddard Space Flight Center, Greenbelt, Md.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 35-44(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Recent theories on supernova explosion and subsequent neutron-star formation indicate that during gravitational collapse when the outer shells of the star might be accelerated to cosmic-ray velocities, a short time-scale (~ microseconds) burst of energetic photons should also be generated. A wave front of energetic photons passing the Earth would be absorbed in the atmosphere and would induce fluorescence emission. A photomultiplier system designed to observe the secondary fluorescence light is described. This system has been in operation since September 1968. An upper limit to the rate supernova-like events is given as one per 86 hours at sensitivity levels discussed in the text. A second system was put into operation in June 1969. The two stations are now operating in coincidence over a baseline of 175 km to remove local noise sources. In 45 hours of observation, only lightning like events have been observed in coincidence. (auth)

31722 INTERPRETATION OF THE PRIMARY ENERGY SPECTRUM AND SIDEREAL DAILY VARIATION MEASUREMENTS WITH RESPECT TO THE PROBLEM OF COSMIC RAY ORIGIN. Dorman, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 45-50(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The simultaneous analysis of experimental data on the energy spectrum, chemical composition, and sidereal daily variation of primary cosmic rays allows one to speculate on the problem of cosmic-ray origin as far as particles of energies $\lesssim 10^{17}$ eV are concerned. It is shown that the CR energy spectrum and chemical composition measurements carried out on the satellites "Proton" are in agreement with the CR sidereal daily variation measurements provided that the nuclear fragmentation does not take place in the interstellar medium (as usually accepted) but in the envelope of the cosmic-ray sources. From this assumption it follows that the lifetime of cosmic-ray particles in the Galaxy is about 10^7 years, in good agreement with CR lifetime measurements of the ^{10}Be content. (auth)

31723 CASCADE PROCESSES IN THE METAGALAXY. Prilutskii, O. P.; Rozental, I. L. (Moscow Engineering Physical Inst.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 51-4(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The interaction of high-energy electrons and photons with electromagnetic radiation in the Metagalaxy is considered. Approximate expressions are obtained for the intensity of background radiation produced in these processes. These results may be used for density estimations of electromagnetic radiation in the Metagalaxy and for speculations on the evolution of cosmic-ray sources. (auth)

31724 ORIGIN OF COSMIC RAYS AT HIGH ENERGIES. Berezinskii, V. S.; Zatsepin, G. T. (Lebedev Inst. of Physics, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 55-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

It has been shown that the cosmic rays observed with energies $E \gtrsim 3 \times 10^{18}$ eV cannot be metagalactic protons. The neutrino hypothesis is discussed. (auth)

31725 ENERGETIC GAMMA-RAY EMISSION FROM THE GENERAL DIRECTION OF THE CYGNUS CONSTELLATION. Valdez, J. V.; Freier, P. S.; Waddington, C. J. (Univ. of Minnesota, Minneapolis). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 79-85(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A combination nuclear emulsion and spark chamber gamma-ray telescope was flown on a high-altitude balloon to study a region in the constellation Cygnus for evidence of possible point source or line source emission of $E > 100$ MeV gamma rays. The telescope used was similar to that described previously and the region surveyed in this observation covered approximately 280 to 315° R. A. and 25 to 45°N declination. In this region lie two potential point sources, Cyg A and Cyg XR-1, together with a section of the galactic plane covering galactic longitudes 1^{II} of 60 to 90°. The response of the detector was calculated using a Monte Carlo simulation. An energy spectrum and flux value for the general background of gamma rays were derived, which were presumably atmospheric in origin. The comparison of these values with those obtained by other workers appears to justify the overall correctness of the Monte Carlo calculation and its use to derive intensity limits for emission from possible sources. Furthermore, a detailed study of the response characteristics improved the conclusions on the significance of the line source emission from the galactic equator. (auth)

31726 HIGH-ENERGY GAMMA-RAY OBSERVATIONS FROM OSO-III. Valentine, D.; Kaplon, M. F.; Badhwar, G. (Univ. of Rochester, N. Y.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 101-9(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Results on high-energy gamma rays obtained from the analysis of 5800 orbits of data from the University of Rochester particle telescope carried in the wheel section of OSO-III are presented. For gamma rays of energy greater than 100 MeV a value of $(1.67 \pm 0.6) \times 10^{-4}$ gammas cm^{-2} sec^{-1} ster^{-1} is obtained. There is a slight indication of an enhancement in flux towards the plane of the Galaxy; enhancement is approximately a factor of one and a half over the isotropic background. An upper limit to the flux from the Sun is set at 2.2×10^{-5} gammas cm^{-2} sec^{-1} for energies greater than 50 MeV (all fluxes assume a π^0-decay source for the gamma rays). (auth)

31727 MEASUREMENTS OF HIGH-ENERGY PRIMARY GAMMA QUANTA ON THE SATELLITES PROTON-2 AND COSMOS-208. Bratolyubova-Tsulukidze, L. I.; Grigorov, N. L.; Kalinkin, L. F.; (and others) (Moscow State Univ.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 123-5(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The upper limits of the intensities of primary γ quanta with energies higher than 50 MeV were determined. The data obtained agree with the results of measurements from Explorer-11 and OSO-III. (auth)

31728 STUDY OF PRIMARY GAMMA RAYS OF ENERGIES HIGHER THAN 100 MeV BY MEANS OF A SATELLITE-CARRIED SPARK CHAMBER. Volobuev, S. A. (Moscow Engineering Physics Inst.); Galper, A. M.; Kirillov-Ugryumov, V. G.; (and others). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 127-9(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Using a device with a multiplate wide-gap spark chamber events corresponding to γ-ray registration were reliably identified and the flux of γ rays was estimated. An attempt was made to isolate galactic γ flux. (auth)

31729 MEASUREMENTS OF THE PRIMARY ELECTRON SPECTRUM IN THE ENERGY RANGE 0.2 MeV TO 15 GeV. Beedle, R. E.; Lezniak, J. A.; Rockstroh, J.; Webber, W. R. (Univ. of Minnesota, Minneapolis). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 131-5(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Measurements at two extremes of the electron energy spectrum are reported. The interplanetary electron intensity below 1 MeV as measured on Pioneer 8 is found to be an extension of the spectrum previously measured in the 2 to 20-MeV range. At energies between 3 and 15 GeV the intensity of primary electrons was deduced to be a factor of 2 to 3 lower than in most previous measurements. The implications of this low electron flux at high energies are discussed. (auth)

31730 HIGH-ENERGY ELECTRON COMPONENT OF THE COSMIC RADIATION. Marar, T. M. K.; Freier, P. S.; Waddington, C. J. (Univ. of Minnesota, Minneapolis). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 137-43(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A composite stack of nuclear emulsions and lead sheets mounted in a spark chamber array triggered by scintillator and gas Cherenkov counters was flown over Texas, U.S.A., for 17 hours to look for energetic electrons with $E \geq 10$ GeV. Thus far about 25% of the total data have been examined. A considerable number of particles detected by the spark chambers whose appearance resembles that expected for primary electrons have been traced into the nuclear emulsions and identified as not being electrons but particles making nuclear interactions. The number of identified electrons found corresponds to an intensity of electrons with $E < 10$ GeV of 0.08 ± 0.06 electrons/m^2 sr sec compared to the value of about 2 electrons/m^2 sr sec reported previously. In an attempt to understand why the results differ from those reported from a pure emulsion detector, a similar direct scan of a sample of the emulsions was made and an electron intensity an order of magnitude or more below that predicted was found. The results combined with those obtained by spark chamber detectors suggest an integral energy spectrum of the form $J(>E) \alpha E^{-3.3 \pm 1.1}$. (auth)

31731 COSMIC-RAY ELECTRONS AND POSITRONS OF ENERGIES 2 TO 9.5 MeV OBSERVED IN INTERPLANETARY SPACE. Cline, T. L.; Porreca, G. (Goddard Space Flight Center, Greenbelt, Md.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 145-9(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The differential energy spectra of electrons and positrons in the 2 to 9.5 MeV interval were studied in interplanetary space during solar quiet times after March 1968 with the OGO-5 satellite. The detector flown was designed to separately identify cosmic and solar electrons, positrons, protons, and alphas, and solar x rays; it used new techniques to minimize its background and to determine directly the background encountered. The observed quiet-time electron spectrum, approximately of the form $90\ E^{-1.5}$ m^{-2} sec^{-1} sr^{-1} MeV^{-1} from 2 to 9.5 MeV, roughly agrees with the expected unmodulated cosmic knock-on electron spectrum. The positron to electron ratio, totalled for this energy interval, is only 1.8%. This is the lowest e^+/e ratio measured in any energy region; it also suggests that this electron component is of knock-on or directly accelerated origin, rather than of meson decay or soft shower origin. The resulting average positron intensity, near 0.2 m^{-2} sec^{-1} sr^{-1} MeV^{-1}, compares with the balloon data above 10 MeV such that all points or upper limits are below the predicted spectrum of cosmic electrons from pion decay by a factor of up to ten. This result indicates a moderate modulation of the positron intensity in the medium energy region, having a detailed energy dependence yet to be determined. (auth)

31732 TIME VARIATIONS OF THE 4- TO 12-MeV INTERPLANETARY ELECTRON INTENSITY BETWEEN 1963 AND 1968. Simnett, G. M.; Cline, T. L.; McDonald, F. B. (Goddard Space Flight Center, Greenbelt, Md.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 151-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The interplanetary electron intensity between 4 and 12 MeV has been monitored with the IMP-1, -3, and -4 spacecraft from November 1963 to April 1964, June 1965 to April 1967, and May 1967 to April 1969, respectively. There are a variety of types of time variations in the intensity; these include flare-associated and recurrent solar electron events, and other short-term effects, such as small quiet-time increases and Forbush decreases, superimposed on the longer-term modulation. The quiet-time intensity increases are strongly correlated with solar rotation, but are generally not coincident with increases of the low-energy proton intensity; in fact, there is frequently an anticorrelation between the two. This pattern indicates the possibility of a solar origin for the quiet-time increases. However, since the background electron intensity does undergo large Forbush decreases, not coincident with solar-flare electron events, the existence of a real solar modulation of the galactic intensity is also indicated. The overall change in the quiet-time background intensity between December 1965 at solar minimum and August 1968 is less than a factor of two, but is not interpreted as vanishingly small. (auth)

31733 INTERPLANETARY POSITRONS NEAR 1 MeV FROM OTHER THAN THE $\pi \rightarrow \mu \rightarrow e$ PROCESS. Cline, T. L.; Hones, E. W. Jr. (Goddard Space Flight Center, Greenbelt, Md. Los Alamos Scientific Lab., N. Mex.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 159-64(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Evidence is presented for a spectral component of interplanetary positrons separate from that produced by the decay of interstellar mesons from cosmic-ray interactions. Results from observations made with the OGO-3 satellite indicate the detection of $\gtrsim$0.5-MeV positrons with a differential intensity near 100 m^{-2} sec^{-1} $ster^{-1}$ MeV^{-1}, two decades higher than the maximum expected from cosmic-ray meson production. Data, accumulated for nearly 2 years, were examined for the existence of temporal or spatial variations; accelerator exposures of the detector are also being made in order to determine if the particles observed in space might be local secondaries. To date, there is no indication of any solar or geophysical production mechanism, or effect local to the detector, which would account for the observed positron rate. The observed cosmic-ray positron intensity taken, to be of cosmic-ray origin, is compared with the calculated values for interstellar beta emission by cosmic-ray excited nuclei; qualitative agreement exists only if a high, possibly local, low-energy cosmic-ray intensity is used. A heliocentric acceleration or some quite different source may instead be required to provide the observed intensity. (auth)

31734 LOW-ENERGY COSMIC-RAY POSITRONS AND 0.51-MeV GAMMA RAYS FROM THE GALAXY. Ramaty, R. (Goddard Space Flight Center, Greenbelt, Md.); Stecker, F. W.; Misra, D. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 165-71(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Large fluxes of low-energy cosmic rays in interstellar space may produce, via unstable CNO beta-emitters, large fluxes of low-energy positrons and a detectable intensity of 0.51-MeV gamma rays. Even though on a galactic scale these cosmic-ray intensities are probably untenable since they conflict with the dynamics of the interstellar medium, they may exist on a smaller scale of the order of the stopping distances of both low-energy cosmic rays and positrons. The results of a detailed calculation were compared with direct positron measurements at the Earth, and the observability of the annihilation radiation above the isotropic x-ray background is discussed. (auth)

31735 COSMIC-RAY NEGATRON AND POSITRON SPECTRA OBSERVED NEAR FORT CHURCHILL IN 1968. Beuermann, K. P.; Rice, C. J.; Stone, E. C.; Vogt, R. E. (California Inst. of Tech., Pasadena). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 173-9(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The differential energy spectra of cosmic-ray positrons and negatrons between 12 and 210 MeV were measured with a balloon-borne magnetic spectrometer launched from Fort Churchill, Canada, in summer 1968. Since the geomagnetic cutoff varies with time, separate spectra for the local day and night intervals are presented. In addition, the corrections for atmospheric secondary electrons are discussed in detail. The solar modulation of the positron flux is compared with the modulation of cosmic-ray nuclei. (auth)

31736 ELECTRON (NEGATRON AND POSITRON) COMPONENT OF THE COSMIC RADIATION. Verma, S. D. (Louisiana State Univ., Baton Rouge). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 181-6(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Various measurements of the energy spectrum of primary cosmic-electrons (negatron and positron) in the 1-MeV to 300-GeV energy interval, taken near the last solar minimum period (1965) are summarized. The energy spectrum of electrons in the interstellar region is obtained. The beta decay origin of low energy (~1 MeV) positrons in the cosmic radiation predicted previously by the author is discussed. A study of the energy spectra of these positrons would provide information about low energy (10 to 100 MeV/nucleon) nuclei (^{12}C, ^{14}N, ^{16}O, etc.) in the interstellar region. (auth)

31737 COSMIC-RAY POSITRONS AND NEGATRONS OF ENERGIES 10 TO 250 MeV AT 85° GEOMAGNETIC LATITUDE. Kniffen, D. A.; Cline, T. L.; Fichtel, C. E. (Goddard Space Flight Center, Greenbelt, Md.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 187-94(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Measurements of the differential intensities of cosmic ray positrons and negatrons were carried out in 1967 and 1968 with balloon flights from Resolute, Canada, near the north geomagnetic pole. The detector used consisted of a magnetic spectrometer incorporating counters and digitized spark chambers; it is capable of identifying incoming electrons and of separating positrons from negatrons from 20 to 250 MeV/c. The August 25, 1967 flight at 2.25 g cm^{-2} atmospheric depth yielded upper limits for the flux. The August 31, 1968 flight was made with the detector modified by the addition of a gas Cherenkov counter and with a larger geometric factor. Its results also failed to yield measurable intensities of positrons and of negatrons partially because of an instrument malfunction which made the net area solid angle collecting time factor similar to the previous year. These findings are compared with the other available results from cosmic-ray positron and negatron experiments in the energy region appropriate to interstellar meson production. It is shown that there is considerable depression of the expected positron intensity presumably by solar modulation effects throughout the entire energy range examined. (auth)

31738 COSMIC-RAY ELECTRONS AT 8.3-GV RIGIDITY CUTOFF ENERGY SPECTRUM AND CHARGE SIGN RATIO. Agrinier, B. (CEN, Saclay, France); Koechlin, Y.; Parlier, B.; (and others). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 203-8 (1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The flux, energy spectrum, and charge composition of primary cosmic electrons were investigated by means of a spark chamber detector flown in balloons from Trapani, (Southern Italy; 8.3 GV rigidity cut-off), in July 1967. An integral flux F_p (>8.3 GeV) = (1.2 ± 0.1) $(m^2 \text{ sec sr})^{-1}$ and a differential energy spectrum (dN/dE) = (24 ± 4) $E^{-(2.3+0.2)}$ $(m^2 \text{ sec sr GeV})^{-1}$, for energies above 8 GeV, were obtained. Between 7.2 and 12.2 GeV the positron fraction deduced from the east–west effect was (0.13 ± 0.10) if the re-entrant albedo electron flux above about 2 GeV, incoming at zenith angle of 38°, was assumed to be isotropic in azimuth; the fraction was reduced to (0.05 ± 0.10) if a ratio $[(F_W/F_E)] = 1.2$ for the re-entrant albedo was assumed. (auth)

31739 TIME VARIATIONS IN THE COSMIC-RAY ELECTRON SPECTRUM ABOVE 500 MeV. Bleeker, J. A. M. (Kamerlingh Onnes Laboratorium, Leiden); Burger, J. J.; Deerenberg, A. J. M.; (and others). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 209-15 (1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Balloon observations in the years 1966, 1967, 1968 as well as satellite observation in the period April 1968 to March 1969 revealed a significant time variation of the cosmic-ray electron intensity in the rigidity range 0.5 to 10 GV. The observed relative modulation above 3 GV rigidity agrees with the rigidity dependent form exp(−K/R), fitted to the Sulphur Mountain neutron monitor rate change. Below 2 GV no significant rigidity dependence is observed, and the modulation is consistent with the form exp(−K/β). A reduction of the electron intensity was recorded by the satellite instrument during several Forbush decreases which follows a similar function of rigidity as in the long-term variation. (auth)

31740 COSMIC-RAY ELECTRON SPECTRUM BETWEEN 0.5 AND 10 GeV OBSERVED ON BOARD OGO-5. Bleeker, J. A. M. (Kamerlingh Onnes Laboratorium, Leiden); Berger, J. J.; Deerenberg, A. J. M.; (and others). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 217-21(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A cosmic-ray detector sensitive to electrons with energies between 0.5 and 10 GeV is flown on board the OGO-5 satellite. The instrument is operating at altitudes between 80,000 and 150,000 km. The cosmic-ray electron spectrum is presented over the period April 15 to May 5, 1968. A considerable flattening of the spectrum at energies below 3 GeV is observed. A substantial part of this flattening is considered to be a genuine property of the interstellar cosmic-ray electron spectrum. (auth)

31741 HIGH-ENERGY ELECTRONS RECORDED ON THE ESRO-II SATELLITE. Marsden, P. L.; Jakeways, R.; Crowden, J. B.; Napier, T. M.; Calder, I. R. (Univ. of Leeds, Eng.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 223-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A Cherenkov scintillation counter arrangement was used to measure the flux of high-energy primary electrons in the energy range 4 to 15 GeV. Details of the detector and its calibration are described. The experiment has been flown on the ESRO II satellite and preliminary observations on the electron intensity are reported. (auth)

31742 COSMIC-RAY ELECTRON SPECTRUM AT ENERGIES >100 GeV. Anand, K. C.; Daniel, R. R.; Stephens, S. A. (Tata Inst. of Fundamental Research, Bombay). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 229-34(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

On the basis of 22 cosmic-electrons of energy >200 GeV observed in an emulsion–lead sandwich assembly exposed under 10.5 g cm^{-2} of residual atmosphere, very suggestive evidence is presented for a steepening of the energy spectrum around 200 GeV. Subject to confirmation of this observation, the important consequences that are likely to follow are: (i) the residence time of cosmic rays is $\approx 6 \times 10^5$ years and the cosmic-ray confinement volume is essentially the galactic disk, (ii) the usually accepted 3.5 g cm^{-2} of interstellar matter traversed by cosmic rays taken in conjunction with (i) will require a mean number density of ≈ 3 hydrogen atoms cm^{-3} in the galactic disk and (iii) if the newly observed background radiation in the sub-millimeter region extends to galactic dimensions, then the residence time of cosmic rays will reduce to $\approx 7 \times 10^4$ years, a value which will lead to such serious difficulties as to cast doubt on this radiation pervading the galactic volume. (auth)

31743 CHARGE COMPOSITION OF THE PRIMARY COSMIC-RAY ELECTRONS BETWEEN 10 AND 30 GeV. Anand, K. C.; Daniel, R. R.; Stephens, S. A. (Tata Inst. of Fundamental Research, Bombay). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 235-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

An experiment was carried out with an oriented pure emulsion stack exposed under 6.0 g cm^{-2} of residual atmosphere to study the fraction of positrons among cosmic-electrons. From a total of 9 electrons so far uniquely identified, the fraction R of positrons among all electrons was found to be ≈0.2 between 10 and 20 GeV. This may be compared with (a) an earlier value of ≈0.7 based on 11 electrons between 10 and 30 GeV, (b) a value of 0.15 ± 0.18 obtained by the Chicago Group at 8 to 15 GeV and (c) a value consistent with zero obtained by the French–Italian Collaboration. It appears from these observations that while positrons are likely to be much less abundant compared to negatrons at energies $\gtrsim 10$ GeV, further experiments are required to estimate it reliably. (auth)

31744 OBSERVATION OF ELECTRON COMPONENT IN COSMIC RAYS WITH EMULSION CHAMBER. Nishimura, J.; Mikumo, E.; Mito, I.; (and others) (Tokyo Univ.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 239-46(1970).

From eleventh international conference on cosmic rays, Budapest, Hungary (25 Aug 1969).

The primary cosmic-electron flux above 30 GeV was measured with a specially designed emulsion chamber consisting of nuclear emulsion plates, tungsten plates, and lead plates. The chamber had an area of 500 cm^2, with a radio control turn-over system, and was exposed over Haramachi, Japan, on September 16, 1968 at an altitude of 6 g/cm^2 for 380.5 minutes. The events obtained by general scanning in the chamber were discriminated carefully against nuclear events, and γ-ray initiated showers. Thus, as the highest-energy electron, one event above 450 GeV was observed within 2160 m^2 sec sr. The spectrum of the primary electron observed in this chamber showed an indication of the existence of the bending point near 50 GeV, and was well represented by a power law spectrum in the energy region 50 to 300 GeV. (auth)

31745 CALCULATION OF INTERSTELLAR INTENSITY OF ELECTRONS. Lal, S. (Univ. of Denver). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 247-50(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

In calculating the intensity of electrons and positrons which are produced through π-μ-e decays, following the nuclear collisions of cosmic-nuclei in the interstellar medium, one usually makes a simplifying δ-function approach for the production spectrum of pions created in each nuclear collision. In this paper the experimentally observed production spectrum, obtained from the analysis of nuclear collisions at machine energies, is used to see its effect on the intensity of interstellar electrons and positrons. (auth)

31746 GALACTIC X RAYS AND GAMMA RAYS. Cowsik, R.; Pal, Yash (Tata Inst. of Fundamental Research, Bombay). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 251-4(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A consistent explanation of the galactic flux of high-energy γ rays observed by Clark et al. (1968) and the galactic x-ray flux reported by Cooke et al. (1969) is provided in terms of Compton scattering of cosmic-ray electrons with the sub-millimeter radiation observed by Shivanandan et al. (1968) and confirmed by Houck and Harwit (1969). It is predicted that the flux of galactic x rays, relative to that of cosmic x rays, will increase with increasing energy. Thus, if an increased enhancement in the flux of high-energy (~200 keV) x rays in going across the galactic equator is not observed, the existence, on a galactic scale, of the sub-millimeter radiation discovered by Shivanadan et al. will be ruled out. (auth)

31747 DIFFUSE COMPONENT OF COSMIC X RAYS AND THE 8.3°K GALACTIC BLACKBODY RADIATION. O'Connell, R. F.; Verma, S. D. (Louisiana State Univ., Baton Rouge). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 255-9(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Assuming that the far infrared radiation, recently measured by Shivanandan, Houck, and Harwit, is galactic, it is shown that inverse Compton scattering of this radiation on cosmic electrons is sufficient to produce the observed flux of diffuse x rays. Some recent experiments seem to support the predicted anisotropy of this flux. An analysis of the production of helium in the "big bang" expansion of the Universe suggests that this radiation is not universal. (auth)

31748 SEARCH FOR A CONSISTENT MODEL FOR ELECTROMAGNETIC SPECTRUM OF THE CRAB NEBULA. Cowsik, R.; Pal, Yash; Rengarajan, T. N. (Tata Inst. of Fundamental Research, Bombay). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 261-6(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

An attempt is made to search for a consistent model to explain the electromagnetic spectrum of the Crab Nebula (Tau-A). Because of the presence of a pulsar in the Crab and because of other indications of continued activity it is assumed that high-energy electrons are being continuously injected from a central region around the pulsar. It is clear that the injected spectrum of electrons, $E^{-1.54}$, indicated by the spectral shape in the radio region, must steepen to a slope larger than 2 at some energy E_i to ensure that the energy input into electrons remains finite. Two classes of models are considered, depending on the overall magnetic field structure. In the class I models the magnetic field is taken as essentially uniform over the whole volume. Three sub-classes of this are investigated; these are distinguished by the criteria that the injection steepening at E_i is at the same energy, earlier, or later than the steepening (at E_c) due to synchrotron energy loss. It is shown that only one of these, namely when E_i is greater than E_c, gives a good fit with the observational details of Crab. However this model predicts that the size of the x-ray Crab should decrease with x-ray energy beyond 40 keV. In the class II models, besides an overall magnetic field, small regions of strong fields are postulated. The two models in this class differ depending on whether the residence time in the strong field region is small or large. On this basis, the parameters characterizing these models are evaluated. It is found that one of these models is capable of reproducing the observed flattening of the spectrum towards the end of the optical region. Some other implications of the models are also discussed and experimental methods of choosing between them are indicated. (auth)

31749 ORIGIN OF GALACTIC GAMMA RAYS AND A TWO-COMPONENT COSMIC-RAY MODEL. Shen, C. S. (Purdue Univ., Lafayette, Ind.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 267-75(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Two possible sources for the intense 100 MeV photons are (1) the decay of π^0 produced in nuclear collisions and (2) the Compton scattering of infrared photons. In the first case the observed directional dependent gamma flux fixes the production rate and its spatial distribution of secondary positrons, rather insensitive to other astronomical parameters. The same is true for the intensity and spatial distribution of 100 GeV electrons in the second case. The electron spectrum, the positron fraction, and the x-ray intensity expected at Earth are estimated based on the above mentioned fixed quantities. They are compared with the experimental data. It is found that a two-component cosmic-ray source model, one with a disk which contributes to the high-energy electrons at Earth and one concentrated at galactic center with a production rate one to two orders of magnitude higher than the disk component, may be necessary to explain the observed data. (auth)

31750 HIGH-ENERGY CHARGED-PARTICLE OBSERVATIONS ON OSO-III. Valentine, D.; Kaplon, M. F.; Badhwar, G. (Univ. of Rochester, N. Y.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 283-9(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Some observations on high-energy charged particles obtained from the University of Rochester experiment on OSO-III are presented. For rigidity greater than 3 GV proton, helium, medium and heavy nuclei integral spectra are found to be similar. For rigidities greater than 10 GV, the asymptotic integral index for helium, medium and heavy nuclei is found to be -1.37 ± 0.05. The proton to helium ratio for rigidity greater than 4.5 GV has a value of 5.7 ± 0.3 constant up to 12.5 GV. The ratio of medium to heavy nuclei has a constant value of 2.56 ± 0.13 from 3 to 34 GV. No significant variation in proton counting rates over the first 5600 orbits was observed. (The Mt. Washington neutron monitor varied from 2226 to 2303 over this interval.) (auth)

31751 MEASUREMENT OF THE PRIMARY COSMIC-RAY PROTON AND ALPHA-PARTICLE SPECTRA ABOVE 10 GeV/NUCL. Pinkau, K. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.); Pollvogt, U.; Schmidt, W. K. H.; Huggett, R. W. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 291-6(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Several successful balloon flights were carried out in 1967 to study high-energy cosmic particles. Results reported here were obtained from two flights launched from Texas, in which altitudes of 5.7 g/cm^2 and 11.4 g/cm^2 were reached and events were registered for about 22 hours. The equipment consisted of spark chambers, different target materials, and an ionization spectrometer for energy determination of incoming particles. After the balloon flights the equipment was calibrated with 10, 20.5, and 28 GeV/c protons from the Brookhaven AGS. These measurements and the balloon data allowed the calculation of the primary cosmic proton and alpha spectra. (auth)

31752 RIGIDITY SPECTRUM OF COSMIC-RAY HELIUM NUCLEI WITH MAGNETIC SPECTROGRAPH. Cowsik, R.; Pal, Yash; Tandon, S. N.; Verma, R. P. (Tata Inst. of Fundamental Research, Bombay). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 297-300(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A magnetic spectrograph using a magnet with a bending power of ~21 kGcm and glass-backed nuclear emulsion plates as particle-trajectory recorders was constructed and flown over Hyderabad. Sixty-seven primary cosmic-ray helium nuclei were traced through the three emulsion plates and accurate coordinate measurements were made to estimate the rigidity of the particles. A value of 1.7 ± 0.3 was obtained for the integral slope of the rigidity spectrum; this value was consistent with other measurements on helium spectrum. The results showed that this instrument is capable of measuring rigidities up to ~50 GV. (auth)

31753 INVESTIGATION OF THE COMPOSITION OF SINGLY CHARGED COMPONENT OF THE PRIMARY COSMIC RADIATION. Bogomolov, E. A.; Karakadko, V. K.; Lubyanaya, N. D. (Ioffe Inst. of Physics and Tech., Leningrad). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 301-4(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The results of balloon flights of the Cherenkov-scintillation counter telescope in 1967 at geomagnetic latitude 47°N are presented. Measurements of energy spectra of singly charged particles at 1.7 to 5.0 GeV (for protons) were carried out in west and east directions at a zenith angle of 60°. The spectra of protons arriving from the west and of those from the east through the solid angle of the device were calculated using the trajectory-tracing method. A sixth degree simulation of the quiescent geomagnetic field of internal origin was utilized. The antiproton—proton flux ratio in the primary cosmic radiation estimated by comparing the measured and calculated spectra turned out to be 0.24 ± 0.05. Some other attempts to explain the effect obtained are discussed. (auth)

31754 ENERGY SPECTRUM OF COSMIC RAYS IN INTERSTELLAR SPACE. Charakhchyan, A. N.; Charakhchyan, T. N. (Inst. of Physics, Moscow. Moscow State Univ.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 305-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

An empirical connection is established between the intensity of the primary radiation in various energy ranges, and the number of sunspot groups, η. It is possible to calculate the energy spectrum of cosmic rays belonging to the sunspot number 0. The spectrum at $\eta = 0$ is probably very close to the spectrum of the radiation in interstellar space. The energy spectrum of protons at $\eta = 0$ in the kinetic energy range $0.1 \leq E \leq 30$ GeV may, to a good approximation, be written in the form $N_p(>E) = 2 \times 10^4 \{[1/(2 + E)^2] - [3/(2 + E)^5]\}$ protons m^{-2} sec^{-1} sr^{-1}. (auth)

31755 CHEMICAL COMPOSITION OF GALACTIC COSMIC RAYS. Syrovatskii, S. I.; Kuzhevskii, B. M. (Lebedev Inst. of Physics, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 313-16(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The data on the composition of cosmic rays and fragmentation parameters in high-energy regions ($E > 1.5$ GeV/nucleon) are considered. These data were used to estimate the most probable values and their uncertainties. The thickness of matter traversed by cosmic rays in the Galaxy is calculated as $x = 5.9 \pm 5$ g/cm^2, 5.3 ± 4.2 g/cm^2 and 9 ± 4 g/cm^2 for three models of propagation; regular, diffusion, and homogeneous, respectively. For these models the charge composition of the sources is discussed. Considering the abundance of helium isotopes and L-nuclei one can conclude that the usually used regular model (slab approximation) is unreliable for galactic cosmic rays. (auth)

31756 GALACTIC ABUNDANCES AND SPECTRA OF COSMIC RAYS MEASURED ON THE IMP-4 SATELLITE. I. HELIUM, MEDIUM, AND VERY HEAVY NUCLEI. Garcia-Munoz, M.; Simpson, J. A. (Univ. of Chicago). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 317-23(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The ratio ^{4}He/(C + N + O) was obtained from the differential energy spectra of ^{4}He, C, N, and O measured from 25 to 170 MeV per nucleon with a particle telescope on the IMP-4 satellite in 1967–1968. The results are in close agreement with earlier measurements at the time of solar minimum in 1965. They confirm both (1) the approximate independence of the relative abundances of He and C, N, O over a wide energy range, and (2) the presence of a significant decrease in the ratio at energies below ~70 MeV per nucleon. The quantitative constraints which these measurements place on a steady-state or equilibrium model for cosmic-ray propagation in the Galaxy are examined. As a further test of cosmic ray propagation the relative abundances of the individual nuclei P, S, Cl, Ar, K, Ca, Sc, Ti, V, Cr, Mn, and the group [Fe + Co + Ni] were determined at 150 MeV/nucleon. The limitations which these results place on the steady state model are discussed. In addition the implications of the measured ratios $S/Si = 0.20$ and $F/O = 1.6 \times 10^{-2}$ are noted at 150 MeV/nucleon. (auth)

31757 GALACTIC ABUNDANCES AND SPECTRA OF COSMIC RAYS MEASURED ON THE IMP-4 SATELLITE. II. Li, Be, B, AND MEDIUM NUCLEI. Garcia-Munoz, M.; Simpson, J. A. (Univ. of Chicago). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 325-30(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The galactic cosmic-ray spectra of the light nuclei Li, Be, B, and the medium nuclei C, N, O were measured in the range 20 MeV/nucleon to 150 MeV/nucleon by the cosmic-ray telescope on board the IMP-4 satellite from May 1967 to May 1968. The L/M ratio was equal to 0.22 ± 0.03 at 120 MeV/nucleon, 0.21 ± 0.04 at 80 MeV nucleon, and 0.23 ± 0.05 at 40 MeV/nucleon. Thus the ratio L/M was essentially constant in the measured energy range and equal to the corresponding ratios measured by other investigators in the range 1 to 22 GeV/nucleon. The individual ratios Li/M, Be/M, and B/M were also essentially constant and equal to the high-energy measurements previously reported. It was found that an equilibrium model with exponential distribution of path lengths and 10 g/cm^2 mean leakage path length can fit the experimental results. The fraction of ^{7}Be in beryllium in the interval 37 to 107 MeV/nucleon was measured and found to be 0.3 ± 0.1. (auth)

31758 RELATIVE ABUNDANCE OF DEUTERONS IN COSMIC RAYS. Biswas, S.; Radhakrishnan, B.; Ramadurai, S. (Tata Inst. of Fundamental Research, Bombay). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 331-6(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Assuming that cosmic-ray deuterons are produced by the interactions of cosmic ray protons and helium nuclei with interstellar matter, deuteron to helium ratios in cosmic rays were calculated using a regular model. In the calculation the following were taken into account (i) the energy dependent cross sections for the production of deuterons, (ii) kinematics of the deuteron producing reactions, (iii) ionization loss of the primary and the secondary nuclei, and (iv) the elastic collisions of cosmic-ray hydrogen and helium nuclei with interstellar matter. The last effect which is important at low energies had not been taken into account in earlier calculations. On comparing the calculated ratios with the available data of ^{2}H/^{4}He ratios measured in cosmic rays, the amounts of matter traversed by the primary cosmic-ray nuclei of energies 24, 40, and 56 MeV/nucleon were obtained as 2.0 ± 1.2, 3.5 ± 1.4, and 5.1 ± 1.0 g/cm^2 of interstellar matter, respectively. (auth)

31759 CHARGE COMPOSITION OF COSMIC-RAY NUCLEI OF ELEMENTS NEON TO NICKEL. Bhatia, V. S. (Panjab Univ., Chandigarh, India); Biswas, S.; Chohan, V. S.; Kainth, P. S.; Pabbi, S. D. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 337-43 (1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A detailed study of the composition of cosmic-ray nuclei of elements neon to nickel was made using two large emulsion stacks exposed in balloon flights from Fort Churchill, Canada, at 3 to 4 g/cm^2 of residual air for about 10 hours in 1963 and 1964. The charge determination was based on the measurement of the Fowler–Perkins parameter in less sensitive emulsions. Using charge indicating interactions, charge calibration was made directly up to Z = 26 without the assumption on the position of the peak due to iron nuclei. 440 nuclei of Z = 10 to 28 of energy >250 MeV/nucleon were analyzed and the relative abundances were obtained for elements neon to nickel in two energy intervals, 250 to 1000 and >1000 MeV/nucleon. Growth curves of the ratios of (Mn + Cr + V)/Fe and (Ti + Sc + Ca)/Fe as a function of the quantity of hydrogen traversed were calculated from the revised Rudstam relation. On comparing the measured and calculated ratios it was found that the observed data on the charge distribution of nuclei Z = 20 – 28 require significant abundances of Ca and Ti, in addition to Fe, in the cosmic-ray source, and a traversal of about 4 g/cm^2 of hydrogen by nuclei of mean energy of about 700 MeV/nucleon. (auth)

31760 SPECTRA AND CHARGE COMPOSITION OF THE LOW-ENERGY GALACTIC COSMIC RADIATION FROM Z = 2 TO 14. Teegarden, B. J.; McDonald, F. B.; Balasubrahmanyan, V. K. (Goddard Space Flight Center, Greenbelt, Md.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 345-51(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Results from the Goddard Cosmic Ray Experiment on OGO-V for the study of charge and energy spectra are presented. The detector system, designed to study the energy range from 5 to 800 MeV/nucleon and charge range from 1 to 14 consists of three different detectors. The low-energy detector consists of a semiconductor dE/dx vs E telescope. The medium-energy detector has three CsI detectors which act as a dE/dx vs E telescope for stopping particles and as a triple dE/dx telescope for penetrating particles. The high-energy detector consists of two CsI scintillators for redundant dE/dx measurements and a sapphire window Cherenkov counter. The energy spectra and relative abundance data are presented and compared with other relevant measurements. Some new features are seen in C/O, C/He, and O/He ratios which seem to favor the hypothesis of a two component model for the origin of cosmic rays. A nearer source which supplies most of the cosmic particles up to 100 MeV/nucleon seems to have an abundance differing in detail with respect to the high-energy cosmic rays particularly in the relative abundances of carbon and oxygen. It appears that all the features seen in the experimental results are not easily explained by considering a single source and different propagation models for path length distributions. (auth)

31761 COSMIC RAYS FROM SUPERNOVA EJECTA. Colgate, S. A. (New Mexico Inst. of Mining and Tech., Socorro). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 353-9(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The theory of the shock origin of cosmic rays has been based upon the predicted behavior of the supposed supernova explosion shock wave traversing the outer envelope of the original star. What is new is the recognition that small mass supernovae (1.5 to 2 solar masses presumably Type I's) are probably far more highly condensed stars (10^9 to 10^{10} g/cc central density) before explosion than was considered in the initial theory by Colgate and Johnson. As a consequence, the explosion shock wave traverses very much higher density matter, and so the point in the star where the shock becomes relativistic $[(1/\sqrt{1-\beta^2}) = \gamma = 2]$ occurs where $\rho \geq 10^4$ gm/cm^3 and the equilibrium temperature behind the shock becomes greater than m_ec^2, $T \geq 6 \times 10^9$ degrees. The electron–positron pair number density is then enormously larger, $\times 10^3$, than the nucleon number density and the dynamic friction and opacity of the accelerated fluid is changed. The shock propagates to lower density and due to the pair opacity, a small mass fraction is accelerated to higher energy $\geq 10^{20}$ eV/nucleon. Nucleon spallation in the shock is reduced, and a fraction of the pairs does not recombine giving rise to roughly 10^{44} ergs of positrons of 10^{15} eV. These conclusions are sensitive to the shock hydrodynamics which still requires more detailed analysis. (auth)

31762 EXPERIMENTAL STUDY OF ISOTOPIC COMPOSITION OF CARBON IN PRIMARY COSMIC RADIATION. Kristiansson, K.; Joensson, G.; Malmqvist, L. (Univ. of Lund, Sweden). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 361-6(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The isotopic composition of carbon was studied in a stack of nuclear emulsions exposed in a balloon flight from Fort Churchill. The masses of the stopping carbon nuclei were determined from photometric mean track width measurements. The isotopic ratio ^{13}C/(^{12}C + ^{13}C) ≤ 0.15 ± 0.06 was obtained. An extrapolation to the cosmic-ray source shows that the ratio must be smaller in the source matter. The result excludes the possibility that cosmic-ray carbon has taken part in those nuclear reactions in which ^{13}C is produced in large amounts. (auth)

31763 CHARGE SPECTRUM OF HIGH- AND LOW-ENERGY HEAVY NUCLEI IN COSMIC RADIATION. Waddington, C. J.; Freier, P. S.; Long, C. E. (Univ. of Minnesota, Minneapolis). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 367-74(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The charge spectrum of cosmic-ray nuclei of sulphur and heavier (Z ≥ 16) was measured at high (E > 7.1 GeV/n), intermediate (E > 1.58 GeV/n), and low (200 ≤ E ≤ 500 MeV/n) energies. In each case nuclear emulsions flown on balloons were used to detect the nuclei and the ionization was measured using a semi-automated densitometer. Preliminary results on the high-energy charge spectra were reported at the Calgary Conference, but those given here are of appreciably greater statistical weight. The spectra at low and intermediate energies have not been previously reported, however, that at low energies is only a provisional result. These spectra are corrected to the top of the atmosphere and compared with those reported by other workers. The relationship of these spectra to those that might exist at hypothetical sources are considered in terms of the slab model of propagation through interstellar space and it is shown that the results are inconsistent with those obtained for lighter nuclei. A path length distribution that favors short path lengths and that is energy dependent appears to provide the best fit to the data. (auth)

31764 CHEMICAL COMPOSITION AND ENERGY SPECTRA OF COSMIC-RAY NUCLEI WITH Z = 3 TO 30. Lezniak, J. A.; von Rosenvinge, T. T.; Webber, W. R. (Univ. of Minnesota, Minneapolis). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 375-9 (1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The chemical composition and energy spectra of cosmic-ray nuclei with Z = 3 to 30 were measured using new instruments carried on balloons and a 5 element telescope aboard the Pioneer 8 space probe. The results of these studies are: (1) The L/M ratio is constant with energy at a value 0.25 ± 0.02 from 100 MeV/n to >22 GeV/n. In addition, no significant variations of the individual Li/M, Be/M, and B/M ratios are observed with energy. These ratios are 0.086, 0.037, and 0.150, respectively. (2) The Be/Li + B ratio is considerably less than predicted on the basis of the known fragmentation parameters. This suggests that some ^{7}Be has decayed. (3) The chemical composition in the Z = 15 to 26 range is consistent with a fragmentation origin from a predominantly iron source. Only propagation models which contain a broad distribution of path lengths can simultaneously explain the L/M ratio and the chemical composition of heavy nuclei. (auth)

31765 COMMENT ON ABUNDANCES OF HEAVY COSMIC RAYS. Clayton, D. D.; Peters, J. G. (Rice Univ., Houston, Tex.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 381-4(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

It is shown that thermal nucleosynthesis during silicon burning at very high temperature and density can produce a relatively flat abundance spectrum similar to that of the cosmic rays between the elements Z = 14 and Z = 26. One cannot argue for a thermal origin of these nuclei, however, because there is no model capable of ejecting them sufficiently rapidly. (auth)

31766 CHARGE COMPOSITION OF THE PRIMARY COSMIC RAYS ABOVE 4.5 GV FOR $3 \leq Z \leq 26$. Dayton, B.; Lund, N.; Risbo, T. (Danish Space Research Inst., Lyngby). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 385-9(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A telescope, consisting of two Cherenkov detectors with different refractive indices and three spark chambers with ferrite core read-out, was flown three times with high-altitude balloons at a geomagnetic cut-off of 4.5 GV. The composition of primary cosmic rays was obtained with individual element resolution up to and including iron. A preliminary analysis of the data indicated that the composition in the iron group is dominated by charge 26 over the energy range observed. The result was not in agreement with recent reports of a preponderance of Z = 24 at intermediate energies. (auth)

31767 CHARGE COMPOSITION OF COSMIC-RAY HEAVY NUCLEI WITH Z > 26. Ivanova, N. S.; Kulikov, V. N.; Gagarin, Yu. F. (Ioffe Inst. of Physics and Tech., Leningrad). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 391-4(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The charge composition of heavy primary particles with Z > 26 was investigated in emulsion stacks exposed on satellites at an altitude of 300 km (Cosmos 213 and Soyuz 5) as well as outside the magnetosphere (Zond 5). The exposed stacks allowed investigation of the ionization of heavy particles within a range of ≈10 cm in emulsion. Preliminary data are presented on the flux of nuclei with $Z \geq 26$ and on the relative abundance (with respect to the Fe-group) of heavy primary particles with $Z \geq 30$, $Z \geq 40$, etc. (auth)

31768 RIGIDITY SPECTRA OF PRIMARY COSMIC-RAY NUCLEI GROUPS. Volodichev, N. N.; Grigorov, N. L.; Savenko, I. A. (Moscow State Univ.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 395-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The ratios of the fluxes of nuclei groups with charges $Z \geq 1$, 2, 6, 16 in the 3 to 16 GV geomagnetic cut-off rigidity range were investigated. From the constancy of these ratios with rigidity it was concluded that the integral spectra of these groups of nuclei are similar between 3 and 16 GV. The measured intensity of various nuclei was noted to be twice as high as that obtained by one group of authors and coincided with another group of results. An increase of the ratio of the fluxes of L ($3 \leq Z \leq 5$) and S ($Z \geq 6$) nuclei was observed with increasing rigidity from 3 to 16 GV. The present work made use of ≈476,000 nuclei with $Z \geq 1$, ≈58,000 nuclei with $Z \geq 2$, ≈8,700 nuclei with $Z \geq 4$, ≈ 6,000 nuclei with $Z \geq 6$, and ≈500 nuclei with $Z \geq 16$ detected with a Cherenkov spectrometer on the satellite Proton-2 during a total exposure of ≈400 m^2 sr sec. The data relate to November–December, 1965. (auth)

31769 HIGHLY CHARGED COSMIC-RAY PRIMARIES. Fowler, P. H.; Kidd, J. M.; Moses, R. T. (Univ. of Bristol, Eng.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 399-410(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The complete results of the balloon exposure of photographic emulsion over Texas in May 1967 are summarized. (auth)

31770 IDENTIFICATION OF TRACKS OF SUPERHEAVY COSMIC RAYS IN PLASTICS. Price, P. B.; Fleischer, R. L.; Nichols, G. E. (General Electric Research and Development Center, Schenectady, N. Y.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 411-16(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Tracks of 70 cosmic rays with $Z \gtrsim 40$ in stacks of plastics + nuclear emulsions flown over Palestine, Texas, were identified in three ways: by the rate of lengthening of conical etch pits along tracks in calibrated Lexan polycarbonate and in Eastman cellulose triacetate (CTA) and by the optical density of the same tracks in emulsion. CTA responds to relativistic nuclei with $Z \gtrsim 38$ and Lexan to relativistic nuclei with $Z \gtrsim 54$. The responses of Lexan and CTA to nuclei with Z > 54 correlate very well and provide evidence for a Pb peak and for one event with Z ≈ 90. The correlation between measurements in the plastics and in the emulsion is not as good. The charge assignment in emulsion is usually higher than that in the plastics by an amount that increases with Z. Further experiments are being planned to explain the discrepancy. (auth)

31771 COMPOSITION OF COSMIC RAYS OF ATOMIC NUMBER 12 TO 30. Price, P. B. (General Electric Research and Development Center, Schenectady, N. Y.); Peterson, D. D.; Fleischer, R. L.; (and others). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 417-22(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Improvements in the chemical processing of Lexan polycarbonate track detectors have made it worthwhile to collect new data on the elemental abundances of cosmic rays with $Z \geq 12$ and with energies below 300 MeV/nucleon. Lexan stacks were exposed in July, 1968, at a residual pressure of 1.8 mbar over Ft. Churchill. The new abundance distribution is consistent with the one reported by the authors previously, but the resolution is higher ($\Delta Z \approx 0.3$ charge unit, $\Delta A \approx 2$ amu at the 1σ level) and the even-Z to odd-Z ratio is larger (≈4.5). The high abundance of Mn at low energy is confirmed (Mn/Fe ≈ 0.5). These measurements in the region $Z \leq 30$ and $0.1 < \beta < 0.45$ are used to predict curves of response of Lexan to cosmic rays with Z > 30 and β up to 0.95. (auth)

31772 PRIMARY COSMIC-RAY PARTICLES WITH Z > 40. Blanford, G. E. Jr. (Washington Univ., St. Louis); Fleischer, R. L.; Fowler, P. H.; (and others). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 423-7(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Cosmic particles with Z > 40 were identified by their tracks in interleaved nuclear photographic emulsions and plastic detectors. Preliminary results are presented from high altitude balloon flights of 40 hr duration, which carried a total detector area of 20 m^2. (auth)

31773 SPECTRA OF HEAVY AND SUPERHEAVY NUCLEI IN STEADY STATE. Cowsik, R.; Pal, Yash; Tandon, S. N.; Verma, R. P. (Tata Inst. of Fundamental Research, Bombay). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 439-44(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The steady-state spectra of the H_3 group nuclei ($20 \leq Z \leq 28$) as well as super-heavy nuclei ($Z \geq 36$) were calculated and compared with experimental results. The study of these nuclei acquires a special significance in the field of cosmic-ray propagation because the former group of nuclei have an extremely high ionization energy loss at low energies and the latter have extremely high interaction losses. It was found that, using the same propagation parameters which are required to understand the ratio of L to M nuclei down to 100 MeV/N, the calculation reproduces fairly well the experimentally measured relative fluxes of He and iron groups of nuclei for energies below ≈1 GeV/N. Further, the calculation gives a reasonable explanation for the high relative abundance of nuclei with $Z \geq 80$ compared with those with $36 \leq Z < 80$. It is shown that a matter-slab model for cosmic-ray propagation fails drastically; in particular it requires a very unreasonable composition of super-heavy nuclei at source. (auth)

31774 SEARCH FOR ANISOTROPIES IN THE UNDERGROUND MUON FLUX. Barrowes, S. C.; Bergeson, H. E.; Larson, M. O.; (and others) (Univ. of Utah, Salt Lake City). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 445-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The arrival directions of 160,861 muons from primaries of energy about 10^{13} eV were determined with resolution better than 1°. The resulting distribution was examined for anisotropies. No anisotropies of compelling significance were found. (auth)

31775 INVESTIGATION OF COSMIC-RAY-INDUCED TRACKS IN METEORITIC MINERALS. Kashkarov, L. L.; Genaeva, L. I.; Malishev, V. V.; Satarova, L. M.; Lavrukhina, A. K. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 449-52(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Two basic cosmic-ray track sources are considered: heavy primaries ($Z \geq 22$) and secondary spallation and fission products by high-energy proton interactions in meteoritic constituents. Experimental data on calibration of track lengths in meteoritic silicate minerals are presented. The investigated minerals were irradiated in the heavy ion and high-energy proton accelerators in Dubna. The results of measuring fossil track densities and length distribution in olivine crystals sampled from several regions of the pallasite Ilimaes are reported. The relation VVH/VH cosmic-ray nuclei $\approx 2 \times 10^{-4}$ was obtained. (auth)

31776 HISTORY OF GALACTIC COSMIC RAYS IN THE SOLAR SYSTEM. Lavrukhina, A. K. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 453-5(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Some results of calculations by a new model of depth distributions of nuclear active particles and nuclear spallation products in meteorites of different chemical composition and different sizes are discussed. A new method for the determination of the shapes of cosmic-ray energy spectra is suggested. It was found that I_0 ($E > 0.2$ GeV/nucleon) = 0.41 particles/cm^2 sec sr and I_0 ($E > 0.6$ GeV/nucleon) = 0.28 particles/cm^2 sec sr. The comparison of calculated and measured contents of ^{22}Na and ^{21}Ne and ^{22}Na/^{26}Al ratios in chondrites shows the constancy of the galactic cosmic-ray flux in the solar system for the last 50 million years. It was found that the modulation region of galactic cosmic rays lies at solar distances of 2 to 5 A.U. (auth)

31777 COMPOSITION OF RELATIVISTIC COSMIC RAYS DETECTED ON GEMINI XI. O'Dell, F. W. (Naval Research Lab., Washington, D. C.); Shapiro, M. M.; Silberberg, R.; (and others). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 457-62(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Final results are presented on the first satellite experiment on abundances of cosmic-ray nuclei having a mean energy of several GeV per nucleon. A nuclear emulsion detector, exposed on Gemini XI in a near-equatorial orbit ranging between geographic latitudes ±29°, collected 619 high-quality tracks above the atmosphere. Time resolution (within about 5 minutes) was provided by movement of a lower emulsion stack relative to an upper one. The detector was covered by only 0.07 g/cm^2 of aluminium, and was favorably oriented for 18 hours. The results on abundances, requiring no correction for secondary production in the atmosphere, are characterized by: (a) a pronounced odd–even effect, with low abundances for elements of atomic numbers 7, 9, 11, and 13, compared to those of neighboring elements with even Z; (b) approximately equal fluxes of neon, magnesium, and silicon, each being about one-fourth that of oxygen; and (c) an abundance gap in the region $15 \leq Z \leq 19$. The composition is similar to that observed at ≈ 100 MeV/nucleon on satellites; however, the abundances of the "heavy" nuclei ($Z \geq 10$) relative to oxygen are higher in this experiment by approximately one standard deviation, or $\approx 20\%$, than those at low energies. (auth)

31778 TRANSFORMATION OF COSMIC-RAY NUCLEI IN SPACE. Shapiro, M. M.; Silberberg, R.; Tsao, C. H. (Naval Research Lab., Washington, D. C.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 463-9(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

An extensive program of calculations was carried out on the transformation and propagation of cosmic-ray nuclei in interstellar space. Stable products between ^{6}Li and ^{56}Fe, as well as decay products of radioactive nuclides, were considered. Procedures of calculation are described; the diffusion equation, the cross sections employed, and the methods adopted for taking into account ionization losses, geomagnetic cutoff, and solar modulation. Secondary, tertiary, and quaternary products of collisions between the primordial nuclei and interstellar hydrogen nuclei were included in the calculations. (auth)

31779 DISTRIBUTION FUNCTION OF COSMIC-RAY PATH LENGTH. Shapiro, M. M.; Silberberg, R.; Tsao, C. H. (Naval Research Lab., Washington, D. C.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 471-7(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The "slab-model" approximation for the thickness of matter traversed by cosmic-ray nuclei in space has been a useful parameter in astrophysics. The actual distribution of path lengths, however, cannot conform to a delta-function, since no unique value of the path satisfies both (a) the observed abundance of the Li, Be, and B group, and also (b) the production, from Fe, of the "subiron" nuclides in the group $17 \leq Z \leq 25$. Investigation of alternative distribution functions—gaussian and exponential—has revealed that the exponential type can satisfy the relative abundances in both regions (a) and (b). Specifically, the function exp [(−0.16 ± 0.04) X] fits both the observed ratios L/M and $(17 \leq Z \leq 25)$/Fe at high energies, and much of the low-energy data as well, down to 100 MeV/nucleon. (auth)

31780 RELATIVE ABUNDANCES OF COSMIC RAYS AT THEIR SOURCES. Shapiro, M. M.; Silberberg, R.; Tsao, C. H. (Naval Research Lab., Washington, D. C.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 479-84(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The relative abundances of the cosmic-ray elements C, N, O, Ne Mg, Si, S, Cr, and Fe at the sources are reported for kinetic energies >1.5 GeV/nucleon. They were found to be 100 : 12 : 105 : 20 : 23 : 20 : 3 : 8 : 23, respectively. These calculated ratios have errors of some 10 or 20%, except for S and Cr which are quite uncertain and are only about 1½ standard deviations from zero. In comparison to solar abundances, and normalizing to carbon, the primordial cosmic rays are relatively less abundant in H and He by a factor of about 10 or 25, less in N by a factor of 2 or 3, and less in 0 by a factor of about 2. On the other hand, heavier elements like Mg and Si are overabundant in the primordial cosmic rays by a factor of 3, while Fe is overabundant by a factor of 12 ± 3. The overabundance of the "superheavy" elements, like lead, appears to be comparable to that of iron. (auth)

31781 LIFETIME OF COSMIC RAYS. Shapiro, M. M.; Silberberg, R. (Naval Research Lab., Washington, D. C.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 485-90(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The effects of the decay of the radioactive ^{10}Be nuclei on the intensity ratios Be/B and Be/Li in the cosmic radiation are explored. A comparison of the calculated abundances with those observed near the top of the atmosphere suggests $T < 10^7$ years for the bulk of cosmic-ray nuclei. This "short" lifetime, if confirmed by more precise cosmic-ray and cross-section data, would favor confinement of cosmic-ray nuclei mainly to the galactic disk. It would also be highly compatible with a galactic origin for nearly all of the cosmic radiation that arrives in the solar system. The absence of inverse Compton and synchrotron losses, which can be deduced from the slope of the positron spectrum, suggests an upper limit: $T < 10^8$ years. (auth)

31782 SEARCH FOR A SIDEREAL ANISOTROPY AT 60 mwe DEPTH. Elliot, H.; Thambyahpillai, T.; Peacock, D. S. (Imperial Coll. of Science and Tech., London). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 491-500(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

An experiment designed to search for a sidereal daily variation in the muon intensity at a depth of 60 m.w.e. has been in operation from 1960 to 1968 in London. The muon flux at this depth arises mainly from primaries in the energy range 10^{11} to 10^{12} eV. There is evidence for a small sidereal variation in the data which, after correcting for the peculiar motion of the solar system, is shown to have an amplitude $\leq 0.02\%$. Primary cosmic rays with energy in the region 10^{11} to 10^{12} eV are appreciably deflected in the interplanetary magnetic field but after taking this into account, it is still difficult to reconcile so high a degree of isotropy with a galactic origin for these particles. Making the usual assumptions about the upper limit to the lifetime of cosmic rays in the galactic disk it is concluded that the observations are most readily explained if the majority of cosmic rays with $E \geq 10^{11}$ eV originates outside the Galaxy. (auth)

31783 SIDEREAL COSMIC-RAY DIURNAL VARIATIONS OBSERVED UNDERGROUND. Swinson, D. B. (Univ. of New Mexico, Albuquerque). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 501-6(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Data from underground μ-meson telescopes, at depths of approximately 40 mwe, in the northern and southern hemispheres confirm that a maximum intensity is observed near 18 hours sidereal time for telescopes pointing into the northern hemisphere and near 06 hours sidereal time for telescopes pointing into the southern hemisphere, in agreement with previous observations by others. A model is proposed in which just such a "sidereal" variation can be produced in the vicinity of the Earth as a result of a radial heliocentric cosmic-ray density gradient in the presence of the interplanetary magnetic field; it predicts the observed times of maximum in the northern and southern hemispheres, without recourse to assumptions about anisotropies of the particle flux in galactic space. Further data analysis tends to support the predictions of the model. (auth)

31784 SIDEREAL AND SOLAR ANISOTROPY OF HIGH-ENERGY COSMIC RAYS OBSERVED BY AN AIR CHERENKOV TELESCOPE. Sekido, Y.; Nagashima, K.; Kondo, I.; Murayama, T.; Sakakibara, S. (Nagoya Univ., Japan). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 507-11(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Previous results of the observation of cosmic-ray anisotropies at $\delta \approx 30°$N presented at the Calgary conference supported the model of the cosmic-ray two-way sidereal anisotropy suggested by Jacklyn. By this model, the axis of the anisotropy is at $\alpha \approx 19$ h in the northern hemisphere, and the observation at $\delta = 0°$ is expected to yield a predominant second harmonic with its maxima at 7 and 19 h. To test this expectation, high-energy cosmic-ray observations at 60° zenith angle were made during the period February 1968 to January 1969. Two declination bands, $\delta \approx 0°$ and 20°S, in the celestial sphere were scanned at two pairs of azimuths. The anisotropy of cosmic rays was obtained after removing the contribution due to meteorological factors, using the differences between the diurnal and semi-diurnal vectors observed at two different azimuths. This analysis was done for each of four seasons in order to obtain the sidereal, the solar, and the anti-sidereal vectors separately. The results of the observation at $\delta \approx 0°$ were consistent with the expectation described above. (auth)

31785 COSMIC-RAY ANISOTROPY IN THE GALAXY. Kolomeets, E. V.; Nemolochnov, A. N.; Zusmanovich, A. G. (Kazakh State Univ., Alma-Ata, USSR). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 513-16(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The anisotropy of cosmic rays in the Galaxy has been observed in a wide range of energy intervals. In the range 10^{13} to 10^{14} eV, the anisotropy amplitude is within 0.1%. Beyond 10^{14} eV the anisotropy amplitude increases with the increase in energy. (auth)

31786 MEASUREMENTS OF PRIMARY COSMIC-RAY SPECTRA IN 10^{10} TO 10^{14} eV ENERGY RANGE FROM PROTON-1, 2, 3 SATELLITES. Akimov, V. V.; Grigorov, N. L.; Nesterov, V. E.; (and others) (Moscow State Univ.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 517-20(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The results are presented of measurements of the spectrum of the primary cosmic-ray protons at 10^{10} to 10^{13} eV and the spectrum of all particles of the primary cosmic-rays at 10^{11} to 10^{14} eV carried out on Proton-1, 2, 3 satellites. The approximating function which describes the proton spectrum is presented. It has been shown that the spectrum of all particles can be represented by superposing the obtained proton spectrum and power spectrum of nuclei with $Z \geq 2$. (auth)

31787 PRIMARY ENERGY SPECTRUM OF COSMIC RAYS IN REGION 10^{13} TO 10^{15} eV. Hlavac, T.; Nesterova, N. M.; Nikolskii, S. I.; Romakhin, V. A. (Lebedev Inst. of Physics, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 521-5 (1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The primary energy spectrum was derived in the 10^{13}- to 10^{15}-eV energy range on the basis of the extensive air shower (EAS) size spectrum measured at the Tien–Shan station (altitude 3340 m a.s.l.). The size interval used was $N = 2 \times 10^3$ to 10^6. It was found that the measured size spectrum cannot be represented by a power law with a constant exponent. The value of the exponent begins to change at $N \approx 3 \times 10^4$. The obtained data were compared with various theoretical calculations and the interpretation of the results is given. (auth)

31788 INTERACTION OF ULTRAHIGH-ENERGY COSMIC RAYS WITH PHOTONS AND NEUTRINOS IN THE UNIVERSE. Konstantinov, B. P.; Kocharov, G. E.; Starbunov, Yu. N. (Ioffe Inst. of Physics and Tech., Leningrad). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 527-30(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The problem of the distortion of the energy spectrum of ultra-high-energy cosmic rays due to the isotropic background of photons and neutrinos is considered. It is shown that the shape of the energy spectrum of cosmic rays in the ultra-high-energy region may yield information on some important astrophysical and nuclear parameters. (auth)

31789 CONFINEMENT OF COSMIC-RAY ELECTRONS. Daniel, R. R.; Stephens, S. A. (Tata Inst. of Fundamental Research, Bombay). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 531-9(1970).

From eleventh international conference on cosmic rays; Budapest Hungary (25 Aug 1969).

Observational data available on cosmic-ray electrons and the various background radiations were analyzed to arrive at the following deductions. (i) Subject to the existence of the isotropic blackbody radiation at 2.7°K, it is shown that cosmic rays are confined to a galactic volume. (ii) The cosmic-ray residence time in the confinement region is very likely to be energy independent between at least about 10^8 to 10^{13} eV. (iii) The directly accelerated electrons have a spectral shape suggesting a low-energy cutoff near 100 MeV arising from a plausible source modulation. (iv) On the basis of the present observations it is shown that the major part of the 3.5 g cm^{-2} of matter traversed by cosmic rays is most probably in interstellar space and not in the source region. (v) Further credibility is provided for the galactic disk model for the confinement of cosmic rays; this indicates a residence time in the neighborhood of 5×10^5 years. (auth)

31790 PHYSICAL DESCRIPTION OF THE PROPAGATION AND PRODUCTION OF COSMIC RAYS IN THE GALAXY. Gloeckler, G. (Univ. of Maryland, College Park); Jokipii, J. R. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 541-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Consideration of cosmic-ray propagation leads naturally to an equilibrium model for cosmic-ray production and storage in the Galaxy. A previous discussion of the problem is generalized and it is shown that the analytical solutions obtained are consistent with observations of the He/C, He/O, and L/M ratios if the source spectra are flat at nonrelativistic energies (i.e., total energy power laws). (auth)

31791 NOTE ON THE TRANSFER OF HIGH-ENERGY COSMIC-RAY PARTICLES IN A MODEL OF THE GALACTIC DISK. Thielheim, K. O.; Langhoff, W. (Univ., Kiel). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 549-55(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The transfer of high-energy cosmic particles through interstellar space is discussed on the basis of a model of the large-scale ordered contribution to the magnetic field in the galactic disk. (auth)

31792 PULSARS AND COSMIC-RAY PREHISTORY. Lingenfelter, R. E. (Univ. of California, Los Angeles). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 557-63(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Observed pulsars appear to have ages and distances which, if they are supernova remnants, would make them significant sources of local cosmic rays. The calculated contributions of nearby sources to the local cosmic-ray intensity over the last 10^6 years show intensity variations which are large, but still within the present experimental bounds. (auth)

31793 COSMIC RAYS AND COSMOLOGY. Prilutskii, O. P.; Rozentai, I. L.; Shukalov, I. B. (Inst. of Cosmic Research, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 565-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Relations between various components of cosmic rays, cosmological parameters, and sources of radiation are considered. Analysis of the production of radio- and x-ray background radiation is considered. (auth)

Stars

Refer also to abstracts 31765, 31847, and 31965.

31794 He^+ TRIPLET LINE INTENSITIES. Daltabuit, Enrique; Cox, Donald P. (Univ. of Wisconsin, Madison). Astrophys. J.; 173: No. 3, 727-9(1 May 1972).

It is shown that theory and observations of helium-triplet line intensities agree within the respective uncertainties, implying that the population of the 2 ^{3}S metastable level is now predictable within about 30%. (auth)

31795 EXCITATION OF NEBULAR SPECTRUM LINES. Kaler, James B. (Univ. of Illinois, Urbana). Astrophys. J.; 173: No. 3, 601-9(1 May 1972).

Evidence is presented that supports Seaton's suggestion that permitted lines in gaseous nebulae, other than those of hydrogen and helium, can be produced by direct photoexcitation by the central star rather than by recombination. Observations are presented for three nebulae in which O III lines are found but for which the He II lines are not present. This finding contradicts recombination theory, which predicts that the O III lines would not appear unless the He II lines are present, as O^{2+} and He^+ have nearly identical ionization potentials. Next, a strong correlation between the ratio of the strengths of the λ3918 + λ3920 and the λ4267 doublets of C II and the temperature of the exciting star is established. Since this ratio shows a range of values of a factor of 13, it seems unlikely that recombination would be the dominant mechanism acting to produce all the lines. This correlation appears to be a sensitive spectroscopic indicator of the temperature of the central star. An equivalent Harmon–Seaton temperature for the central star of IC 4997, which is not directly observable, is found to be 54,000°K. The observations indicate that the λ3918 + λ3920 doublet is produced dominantly by direct excitation of C^+ whereas the λ4267 line may indeed be principally a recombination line from C^{2+}. (auth)

31796 CHEMICAL COMPOSITION OF THE B-TYPE SUBDWARF HD 4539. Baschek, Bodo (Univ., Heidelbert); Sargent, Wallace L. W.; Searle, Leonard. Astrophys. J.; 173: No. 3, 611-18(1 May 1972).

HD 4539 is one of the brightest known members of the class of early-type high-latitude stars with very weak helium lines. Its spectrum is compared to that of the standard main-sequence star ι Her (which has already been studied by others in detail), and a differential model-atmosphere abundance analysis is reported. The He/H ratio is found to be 16 times smaller in the subdwarf than it is in normal B stars of the solar neighborhood. The abundance peculiarities of this star are not confined to helium. The N/H ratio is higher than normal by a factor of 3 and the O/H ratio is lower than normal by a factor exceeding 10 while the C/H ratio is normal. The origins of this remarkable composition are considered, but no convincing hypothesis is put forward. It is argued that the helium deficiency in this star cannot be regarded as evidence for a low primordial helium abundance. (auth)

31797 SCANNER ABUNDANCE STUDIES. IV. OBSERVATIONS OF SOME STRONG-CN AND MISCELLANEOUS EVOLVED STARS. Taylor, Benjamin J. (Princeton Univ., N. J.); Spinrad, Hyron; Schweizer, Francois. Astrophys. J.; 173: No. 3, 619-30 (1 May 1972).

Scanner observations are presented of a number of strong-CN stars observed by Schmitt and also by McClure, together with observations of a number of other stars from various sources. It is found that the metallicities of some of these stars—particularly from the first group mentioned—compare favorably with the most extreme super-metal-rich stars previously found. By considering the photometry of all stars that have been both scanned and observed with the David Dunlap Observatory system, a loose but definite correlation between DDO gravity-corrected CN strengths and scanner metallicities is found, provided that the latter exceed the solar value. (auth)

31798 MODIFICATION OF THE AVRETT–KROOK TEMPERATURE-CORRECTION PROCEDURE. Karp, Alan H. (Univ. of Maryland, College Park). Astrophys. J.; 173: No. 3, 649-52 (1 May 1972).

A variation of the Avrett–Krook temperature-correction procedure is presented that improves the convergence properties in the surface layers. (auth)

31799 ANALYSIS OF THE WHITE-DRAWF ECLIPSING BINARY BD + 16°516. Young, Arthur; Nelson, Burt (San Diego State Coll., Calif). Astrophys. J.; 173: No. 3, 653-64(1 May 1972).

Previous studies have demonstrated that the star BD + 16°516 is a member of the Hyades, and is a close binary system consisting of a main-sequence K star and a white dwarf that is totally eclipsed. The present study consists of a more definitive analysis of this system based upon recent and more complete data. (auth)

31800 RELATIVISTIC RUNAWAY FROM COLLAPSED MATTER. Case, Lloyd A. (Ames Research Center, Moffett Field, Calif.). Astrophys. J.; 173: No. 3, 665-9(1 May 1972).

When an evolving distribution of matter radiates energy from a central dense core, orbiting satellite matter may be released (or run away) due to lessened gravitational attraction. Investigation of the criteria of release and effects of subreleasing changes is made in relativity, and comparison is made with the classical predictions. The divergences are significant in the case of collapsed objects. (auth)

31801 REDUCED-PROPER-MOTION DIAGRAMS. Jones, Eric M. (Los Alamos Scientific Lab., N. Mex.). Astrophys. J.; 173: No. 3, 671-6(1 May 1972).

Photometric and astrometric observations of proper-motion objects were used to construct analogs of H–R diagrams. Four groups were prominent in the diagrams. These were identified with MK class III, MK class V, class sd, and classical degenerates (white dwarfs). The diagrams were used to predict the location of red degenerates. It is suggested that some stars classified as subdwarfs may be degenerate stars with masses near 0.1 $M_\odot$ as calculated by Chin and Stothers. These stars may also be identified with the "Eggenites." (auth)

31802 HIGH-DENSITY NUCLEON LOCALIZATION. Coldwell, Robert Lynn (Univ. of Washington, Seattle). Phys. Rev., D; 5: No. 6, 1273-85(15 Mar 1972).

A nucleon system interacting by means of the Reid soft-core potential is considered at the very high densities which would be found in the core regions of neutron stars. The question of nucleon localization is considered, first with a simple Wigner-type calculation and then with a variational calculation in which the degree of crystallization is used as a variational parameter. The conclusion is that for some range of densities between $r_0 = 0.2$ F and $r_0 = 0.8$ F $(V/N = 4\pi r_0^3/3)$ nucleons should localize in the sense that a crystal-like wave function which introduces particle anticorrelations by localizing the particles with respect to a periodic lattice is preferable to a plane-wave type of wave function which has only statistical correlations and that this is probably not true outside this region. There is no attempt to distinguish liquids from crystals, merely a gas from a crystal. The energy upper bounds resulting from the variational calculation are also given. (auth)

31803 PARALLAXES, MASS RATIOS, AND MASSES FOR THE VISUAL BINARY STARS BD + 75°403, ADS 9094, AND ADS 9716. Hershey, John L. (Swarthmore Coll., Pa.). Astron. J.; 77: No. 3, 251-3(Apr 1972).

Series of plates taken with the Sproul 24-inch refractor extending over more than three decades were used to determine parallaxes and masses for three visual binaries. The parallaxes and mass ratios are quite accurate; the small parallaxes of these stars result in relatively large errors for the masses. (auth)

31804 LIGHT VARIATION OF UZ LEONIS. Binnendijk, L. (Univ. of Pennsylvania, Philadelphia). Astron. J.; 77: No. 3, 246-50(Apr 1972).

A total of 537 observations in yellow light and a total of 533 observations in blue light of UZ Leonis are presented. The light curve shows complete eclipses with the secondary minimum being the total eclipse. Maximum light occurs at phase angles 86 and 274°. The components of the system are too distorted to give reliable elements according to the Russell model. (auth)

31805 LIGHT VARIATION AND ORBITAL ELEMENTS OF RW CORONAE BOREALIS. Binnendijk, L. (Univ. of Pennsylvania, Philadelphia. Kitt Peak National Observatory, Tucson, Ariz.). Astron. J.; 77: No. 3, 239-45(Apr 1972).

A total of 639 observations in yellow and blue light of RW CrB are presented. The light curve is in good agreement with photoelectric observations made by Carr. The eclipses are partial grazing with primary minimum caused by the transit eclipse. The orbital elements agree satisfactorily with those derived by Pierce. (auth)

31806 NUMERICAL ANALYSIS OF THE VARIATIONS IN THE LIGHT CURVE OF W URSAE MAJORIS. Rigterink, Paul V. (Univ. of Pennsylvania, Philadelphia). Astron. J.; 77: No. 3, 230-8(Apr 1972).

Photoelectric observations of W Ursae Majoris in the B and V wavelength regions are presented. The light curves are compared with previous observations, and the changes in the light curve are noted. It is found that the light curve can be separated into a mean binary light curve which can be explained using standard theories and disturbing light curve which is only partially understood. New orbital elements are derived for the system using the mean binary light curve. In addition, an analysis is made of the validity of the present and previous solutions. (auth)

31807 FAINT O-B2 STARS IN THE VELA, CARINA, CENTAURUS, AND CRUX SECTIONS OF THE SOUTHERN MILKY WAY. Miller, Ellis W. (Univ. of Arizona, Tucson. Cerro Tolodo Inter-American Observatory, La Serena, Chile). Astron. J.; 77: No. 3, 216-29(Apr 1972).

Photographic UBV plates and photoelectric UBV standard sequences were combined to search for faint blue stars in five regions of the southern Milky Way. The search resulted in the identification of 39 new stars of spectral type B2 and earlier which were fainter than V = 13. Minimum distances for the stars ranged from 5 to more than 10 kpc from the Sun. Total absorption values as large as 4 mag occurred in some of the fields. A working model of the Carina spiral feature is presented which displays the distributions of neutral and ionized hydrogen, OB stars, Cepheids, and cosmic dust. (auth)

31808 RADIAL-VELOCITY MEASURES OF θ HERCULIS. Shapiro, Lee (Northwestern Univ., Evanston, Ill.). Astron. J.; 77: No. 3, 215(Apr 1972).

No radial-velocity variations were found for θ Her, indicating that it is not an eclipsing binary. (auth)

31809 ENVELOPE OPACITIES AND THE CEPHEID LOOPS AT 5 $M_\odot$. Robertson, J. W. (Australian National Univ., Canberra). Astrophys. J.; 173: No. 3, 631-6(1 May 1972).

Theoretical evolutionary tracks for the stage of core helium burning have previously been unable to explain the detailed distribution in the H-R diagram of the red giants in NGC 1866, a cluster in the Large Magellanic Cloud. Models calculated with improved envelope opacities develop extremely deep convective envelopes at the tip of the red-giant branch. The convective envelope modifies the hydrogen distribution in the region near the hydrogen-burning shell, which leads to core-helium-burning evolution in better agreement with the observations. (auth)

31810 WEAK s-PROCESS IRRADIATIONS. Peters, James G. (Louisiana State Univ., Baton Rouge); Fowler, William A.; Clayton, Donald D. Astrophys. J.; 173: No. 3, 637-48(1 May 1972).

The overabundances of rare neutron-rich species produced when seed nuclei between silicon and nickel are exposed to small neutron irradiations are calculated in order to ascertain whether those species may owe their natural abundances to such a cause. Particular attention is given to ^{54}Cr and ^{58}Fe, two relatively prominent neutron-rich species that have been bypassed by calculation of explosive nucleosynthesis. Although it is possible that ^{58}Fe is due to weak s-processes, it seems unlikely that ^{54}Cr can be produced along with it because its calculated overabundance is so much less than that of ^{58}Fe. Uncertainties in key neutron-capture cross-sections do not allow this statement to be made unequivocally, however. If ^{58}Fe is due to weak s-process irradiations, moreover, it seems that certain lighter species synthesized satisfactorily in explosive oxygen and silicon burning, such as ^{37}Cl and ^{41}K, must also be synthesized in the s-process. This is unlikely and therefore it is doubted that the s-process has played a major role in the synthesis of these nuclei. Accordingly, the origins of ^{54}Cr and ^{58}Fe remain somewhat of a mystery. The suggestion of Amiet and Zeh that the r-process nuclei are the heavy seeds for the s-process is ruled out. (auth)

31811 QUESTION OF GRAVITATIONAL COLLAPSE. Reinhardt, Michael (Univ., Bonn). Naturwissenschaften; 59: No. 1, 7-12(Jan 1972). (In German).

After some remarks on the final states of stellar evolution (white dwarfs, neutron stars), the gravitational collapse of a spherical object is discussed. The issue of anticollapse is critically reviewed. The collapse of a rotating object, and the possibilities of extracting energy from black holes are treated. Some ways to detect collapsed objects are discussed. (auth)

31812 SYMMETRIC FISSION OF SUPER HEAVY NUCLEI AND OVERABUNDANCE OF RARE EARTH ELEMENTS. Ohnishi, T.; Okamoto, H. (Kyoto Univ.). Nature (London) Phys. Sci.; 236: No. 63, 27-9(13 Mar 1972).

The production of superheavy elements in the Universe by the r-process is discussed, together with their induced and spontaneous fission. It is found that r-process abundances in the rare-earth region are high compared with calculated abundances. Calculations by the authors suggested an overabundance curve having a peak at A = 164, and the pattern of this curve corresponds well to that of the mass-yield curve of symmetric fission of superheavy elements of A = 325. It is therefore suggested that the overabundance in the rare-earth region may be due to accumulation of the fragments from the symmetric spontaneous fission of superheavy elements. It is pointed out that rare-earth abundances in other stellar systems are not necessarily the same as in the solar system, and that r-process conditions in individual stellar systems may possibly be deducible from rare-earth abundances. (UK)

31813 VARIABLE WHITE DWARFS. Chanmugam, G. (Louisiana State Univ., Baton Rouge). Nature (London) Phys. Sci.; 236: No. 67, 83(10 Apr 1972).

The existence of variable white dwarfs has been confirmed spectroscopically and photometrically, and they have been found to have periods between about 200 and 1600 s. Since their radial pulsation periods are of the order of a few seconds an attempt has been made to explain them in terms of rotation, by analogy with pulsar theories, although the erratic nature of the periods presents some difficulties. An alternative explanation is here suggested in terms of nonradial oscillations of white dwarfs and, in particular, their gravity modes. The question is, however, how nonradial oscillations can be excited. (UK)

31814 MODEL FOR THE EJECTION OF MATTER FROM CERTAIN PLANETARY NEBULAE. Louise, Raymond; Roux, Simone (Univ., Marseille. Univ. Lyon, Saint-Genis-Laval, France). Compt. Rend., Ser. B; 274: No. 4, 294-7(24 Jan 1972). (In French).

A model for the ejection of matter from the cores of planetary nebulae is presented. When the radiation pressure is exactly compensated by gravitation, matter ejection may take place as a result of rotation of the star. The almost flat form of the rings of NGC 6720 (observed by Hua and Louise (1971)) is explained by such a mechanism. (France)

31815 ABUNDANCES IN K GIANT STARS. Gottlieb, David Murray. College Park, Md.; Univ. of Maryland (1971). 130p. University Microfilms Order No. 72-12,757.

Thesis.

The use of a computer program to calculate synthetic stellar spectra has made it possible to determine how physical atmospheric parameters will change narrow-band colors. Therefore, given a body of photometry, it is possible to determine at least some of the physical parameters for each star. This has been done for 131 stars of spectral type G8 to K4, and luminosity class III, using the photometry of Spinrad and Taylor (1969). The major result of this study is that there exists a class of stars with metal abundances considerably higher than those of the Sun. This class of stars is also found to have space motions typical of moderately old Population I stars. It is found that the surface gravity of luminosity class III stars decreases and the Doppler broadening velocity increases as temperature decreases. The Doppler broadening velocity is found to be a parameter which depends primarily on temperature and surface gravity. Finally, the mass-luminosity relation of Iben (1967), coupled with the gravities found from the Spinrad and Taylor (1969) photometry, is used to obtain the distances to the 131 stars. (Diss. Abstr. Int., B)

31816 SPECTROSCOPIC INVESTIGATION OF THE TWO DOUBLE-LINED BINARY MERCURY STARS HR 4072 AND CHI LUPI. Dworetsky, Michael Moses. Los Angeles; Univ. of California (1971). 279p. University Microfilms Order No. 72-11,882.

Thesis.

Equivalent widths were measured on several 2-Å/mm coudé spectrograms of the double-lined binary Hg-syndrome stars HR 4072 (30 H UMa) and χ Lupi in order to analyze the primary stars, and to determine the nature of the secondary stars. Detailed abundance analyses were performed by using model atmospheres generated with the ATLAS code. For both primaries $T_{eff} = 11100°K$, and $\log g \simeq 3.9$ to 4.0. The secondaries have $T_{eff} \simeq 9500°K$, and assumed surface gravities $\log g = 4.2$. The rotational velocities are $v_e \sin i \lesssim 2$ km/sec for both primaries and $v_e \sin i \lesssim 4$ km/sec for both secondaries. (TSS) (Diss. Abstr. Int., B)

31817 TIME DEVELOPMENT OF AXISYMMETRIC SHOCK: QUASI-STATIONARY VELOCITY APPROXIMATION. Hashimoto, Yoshiaki (Hirosaki Univ., Japan). Progr. Theor. Phys. (Kyoto); 47: No. 1, 83-104(Jan 1972).

Propagation formulae for an axisymmetric shock wave in a continuous, inhomogeneous medium are derived through hydrodynamic considerations on state of the flow immediately behind the shock, with the use of orthogonality conditions between shock rays and their fronts as well as the shock relations. Quasi-stationary velocity of isentropic flow in a steady gravitation is approximately assumed. The method is applied to an explosion of a highly rotating oblate star. From the computational results, it is seen that the validity of the approximation of quasi-stationary velocity is restricted to the case in which incidence angle of ray on an equidensity surface is comparatively small, less than the so-called critical angle. Within the validity, it is shown that shocks going to higher latitudes grow up more rapidly than to lower latitudes. Further, it is proposed that unsteady flow behind the steeply inclined strong shock will produce strong vorticity and the shock may become absolutely unstable. (auth)

31818 BLACK HOLES AND GRAVITATIONAL THEORY. Penrose, Roger (Birkbeck Coll., London). Nature (London); 236: No. 5347, 377-80(21 Apr 1972).

There have been several recent claims to have detected "black holes." The theoretical basis of "black holes" and some of the recent thinking on the subject are reviewed. (auth)

31819 POLARIZATION MEASUREMENTS OF 1660 SOUTHERN OB STARS. Klare, G. (Landessternwarte, Heidelberg); Neckel, Th.; Schnur, G. Astron. Astrophys., Suppl. Ser.; 5: No. 3, 239-62(Mar 1972).

For all 1660 OB stars of the Heidelberg catalogue (Klare and Szeidl, 1966) polarization data were measured and are presented in a catalog. The stars common with Hiltner (1956) were compared and show a good agreement. Mean errors of the degree and of the direction of polarization are given. (auth)

31820 NUCLEOSYNTHESIS OF SUPERHEAVY ELEMENTS IN THE UNIVERSE. Ohnishi, Teruaki (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 3, 845-66(Mar 1972).

The possibility of the formation of superheavy nuclides in the nuclear region around Z = 114 and N = 184 is investigated by using the model of r-process nucleosynthesis. The r process is calculated by introducing various types of fission phenomena. It is clear that the superheavy nuclides of A $\gtrsim$ 290 can be synthesized on the neutron capture path under the condition of higher neutron number density than that given by the equation: $N_n(\mathrm{cm}^{-3}) = 7.52 \times 10^{23} T_9^{4.62}$, where the T_9 is the temperature in units of 10^9°K. The abundances after the cooling of the r process is also calculated, and it is clear that a large amount of superheavy nuclides can exist even after the arrival at the beta-stability line. The above condition is rather loose for the r process and hence the superheavy nuclides can be produced in many types of astronomical objects, although the situation may be changed if the effect of the spontaneous fission from excited levels is included at high temperature. (37 references). (auth)

31821 THERMONUCLEAR DETONATION AND BETA-INDUCED REIMPLOSION OF DENSE STELLAR CORES. Bruenn, Stephen W. (Florida Atlantic Univ., Boca Raton. New Mexico Inst. of Mining and Tech., Socorro). Astrophys. J., Suppl. Ser.; 24: No. 207, 283-318(Mar 1972).

Detonation self-consistency tests are performed for matter consisting of the products of helium burning and the products of carbon burning in the density and temperature ranges $5 \times 10^6 \leq \rho \leq 3 \times 10^{10}$ g cm^{-3}, and $10^8 \leq T \leq 5 \times 10^8$ °K. Two effects not included in prior investigations are included. (1) The nuclear abundances following detonation are assumed to be distributed in accordance with nuclear statistical equilibrium. (2) The modifications of the equation of state due to ion–ion correlations are taken into account. The former causes the nuclear energy released across the front to decrease with density, and the latter causes a significant reduction in the temperature behind the igniting shock. As a result, the possibility of detonation at high densities in material consisting of the products of carbon burning is in doubt. The effect of β-processes on the postdetonation evolution of dense stellar cores is studied by detailed numerical hydrodynamic calculations. These were performed for a total of 14 different models with initial densities in the range $6 \times 10^9 \leq \rho \leq 3 \times 10^{10}$ g cm^{-3}, and compositions consisting of helium- or carbon-burning products. The results provide a fairly comprehensive picture of the postdetonation evolution as a function of central density, composition, and the rates of the β-processes. (The latter was obtained by scaling the β-rates in three of the models.) An important feedback effect between the outer and inner mass zones is found to occur, the net effect of which is to require very high central densities ($\gtrsim 1.5 \times 10^{10}$ g cm^{-3}) in order that a gravitationally bound remnant be left after detonation, and densities greater than $\sim 3 \times 10^{10}$ g cm^{-3} in order that a collapse to neutron densities be initiated. The implications of these results for nucleosynthesis and the initial collapse to neutron densities are discussed. (auth)

31822 OPTICAL APPEARANCE OF A STAR ORBITING AN EXTREME KERR BLACK HOLE. Cunningham, C. T.; Bardeen, J. M. (Univ. of Washington, Seattle). Astrophys. J.; 173: No. 3, L137-42(1 May 1972).

A star in circular orbit in the equatorial plane of an extreme Kerr black hole (a = m) emits radiation isotropically in its own rest frame. However, due to Doppler effects and the focusing of light in the gravitational field of the black hole, the star's apparent luminosity, seen by a distant observer, will vary periodically. This luminosity may become large compared to its Newtonian value during time intervals short compared to the orbital period of the star, especially if the direction to the observer from the star lies near the equatorial plane. Observation of such a variable source would provide considerable information about the companion black hole. (auth)

31823 SUPERFLUIDITY IN NEUTRON MATTER. Krotscheck, E. (Univ., Cologne). Z. Phys.; 251: No. 2, 135-40 (1972).

The question of superfluidity in neutron matter is investigated in the framework of BCS–Bogolyubov theory. Solving the gap equation for a semi-realistic hard-core and a soft-core potential, a rapidly converging numerical method is developed. The results are applied to neutron star models. (auth)

31824 FIRST ULTRAVIOLET STELLAR SPECTRA FROM THE ORBITING STELLAR SPECTROPHOTOMETER S.59. Hoekstra, R. (Astronomical Inst., Utrecht); van der Hucht, K.; Kampermann, Th.; (and others). Nature (London) Phys. Sci.; 236: No. 69, 121-2(24 Apr 1972).

It is stated that this instrument, carried by the ESRO satellite TD 1A, launched from the Western Test Range, California, made its first observations of high-resolution uv stellar spectra on March 20, 1971. The spectra were observed in three wavelength bands 90 Å wide, centered around 2110, 2540, and 2820 Å, with a resolution of 1.8 Å. From these spectra it is hoped to extract information on the chemical composition of, and the physical conditions in, the atmospheres of hot stars of spectral types O, B, and A, leading to a better understanding of the evolution of these relatively young galactic objects. A description of the instrument and optical layout and method of conduction of the experiment is given. The profiles of the Mg II lines in the spectrum of β Aur (spectral type A 2V) are shown, together with the spectrum of the same star in the 2500 Å channel compared with a theoretical spectrum of an AO-type star. The near uv spectra of A-type stars are evidently dominated by lines of singly ionized metals. (UK)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 31725, 31792, 31976, and 32244.

31825 HOW MANY VARIABLE EXTRAGALACTIC SOURCES AT λ3.8 cm? Brandie, G. W. (Univ. of Michigan, Ann Arbor). Astron. J.; 77: No. 3, 197-200(Apr 1972).

Forty-seven sources found in a λ3.8–cm sky survey were examined for variations in flux density. Over-all, 32% of the sources (15 out of 47) were found to be variable. When sources which had the highest observed signal-to-noise ratio and which were observed over more than 1200 days were considered, the proportion of variable sources rises above 50%. Thus most of the sources with flat or inverted microwave spectra are rather rapid variables. Over the entire sky, there should be about 300 or more sources stronger than 1 f.u. at λ3.8 cm which vary within a time period of only three years. (auth)

31826 CENTIMETER-WAVELENGTH OBSERVATIONS OF THE RADIO NEBULAE NRAO 588/589 AND 4C51.12. Butler, R.; Hughes, V. A. (Queen's Univ., Kingston, Ont.). Astron. J.; 77: No. 3, 201-6(Apr 1972).

The detailed properties of the two radio nebulae were obtained from accurate radio observations and from a precise knowledge of distance. Both sources may be classified as average radio nebulosities. One is a further example of a combination of thermal and nonthermal sources while the other is one of the outermost H II regions in the Galaxy. (auth)

31827 DISTANCE ESTIMATES FOR TWO THERMAL GALACTIC RADIO SOURCES. Bridle, A. H.; Kesteven, M. J. L. (Queen's Univ., Kingston, Ont.). Astron. J.; 77: No. 3, 207-9 (Apr 1972).

Kinematic distances of 3.2 and 4.1 kpc are suggested for the thermal galactic ratio sources NRAO 589A and 4C 51.12 from observations of their 21-cm absorption profiles. (auth)

31828 EXPANDING RING OF INTERSTELLAR GAS WITH CENTER CLOSE TO THE SUN. Hughes, V. A.; Routledge, D. (Queen's Univ., Kingston, Ont.). Astron. J.; 77: No. 3, 210-14 (Apr 1972).

Evidence is given to support the concept of an expanding elliptical ring of dense H I with major and minor axes of 1300 and 560 pc. The ring is at a temperature much below that of the surrounding medium and is a source of anomalous OH emission. The kinetic energy of expansion is at present greater than 10^{51} erg and the velocity of expansion, if at the speed of sound, is consistent with a temperature for the interstellar gas of about 2500 K. The ring appears to be the remains of a large explosion, possibly a Type-III supernova which, in the neighborhood of the Sun, occurs at a rate of about one every 10^7 years, and which liberates about 10^{53} erg of energy. (auth)

31829 FLUX DENSITIES AND SPECTRA OF EXTRAGALACTIC RADIO SOURCES. Niell, Arthur Edwin. Ithaca, N. Y.; Cornell Univ. (1971). 312p. University Microfilms Order No. 72-13,171.

Thesis.

Relative flux density measurements were made at 430, 606, 318, and 111.5 MHz using the Arecibo Observatory 1000-ft spherical antenna. Calibration was based on the scale of Kellermann, Pauliny–Toth, and Williams (1969). The errors due to confusion and receiver noise fluctuations at 318, 430, and 606 MHz were 0.17, 0.15 and 0.07 fu, respectively, with percentage errors of 4, 5, and 7%. At 111.5, 318, and 606 MHz sources suspected or known to have a peculiar spectrum below 1400 MHz were observed. At 430 MHz all sources from the Parkes Catalogue in the declination range 0° to +20° (Day et al., 1966) were observed, reducing the uncertainty in the flux densities near 400 MHz from 30% for the Parkes measurements to about 7% for the Arecibo measurements for the weaker sources. The spectra below 1400 MHz of the galaxies, quasars, and blank fields in the complete sample were significantly different. The Maximum Likelihood estimate of an integral power law exponent for the number-flux density relation for the complete sample was 1.70 ± .12. Flux density measurements were also made for several hundred 4C sources at 750 and 1400 MHz with the 300-ft telescope at NRAO. (TSS) (Diss. Abstr. Int., B)

31830 STATIC PHOTOIONIZATION MODELS FOR EMISSION-LINE REGIONS OR QUASI-STELLAR OBJECTS AND SEYFERT GALAXIES. Mac Alpine, Gordon Madeira. Madison, Wis.; Univ. of Wisconsin (1972). 185p. University Microfilms Order No. 72-4287.

Thesis.

Ionization and thermal equilibrium equations are solved for a gas cloud which is ionized by a source of ultraviolet radiation with the spectrum falling off slowly to higher frequencies as a power law. Elements considered are H, He, C, N, O, Ne, Mg, Si, S, and Fe. The effects of diffuse ionizing radiation, produced within the gas, are taken into account using a somewhat simplified transfer calculation for a spherical geometry. The computations do not include dynamical considerations or the effects of dust. Basing the power-law input of ionizing radiation, along with other physical conditions in the gas, on observations for the quasi-stellar object 3C 273, sets of models are computed that examine how the gas is affected by changes in the spectral power-law index, filling factor, total nuclear density, helium abundance, and absolute luminosity at the source. In each of the above cases, results are presented and discussed for the ionization and thermal structure of the gas along with predicted intensities for a number of emission lines. It is indicated that observations of Ne III and Ne V lines may be helpful in solving the question of helium abundance in quasi-stellar objects. Results are also presented for two models in which the physical parameters of the gas are representative of conditions in the nucleus of the Seyfert galaxy NGC 4151. For the first case, the input of ionizing radiation has the form of a power-law while the second model employs the spectrum which comes about from passing a 500 km/sec shock wave through the medium. The results for both forms of input radiation are found, with some exceptions, to be markedly similar and comparison of theoretical and observational emission-like strengths suggests the use of a composite of the above spectra. Results from all the models indicate that, for a relatively flat input spectrum of ionizing radiation, the contributions of elements heavier than helium, along with inner-shell photoionization, are important to the opacity at high frequencies. Also found to be significant are dielectronic recombination, $H + O^+ \rightarrow H^+ + O$ charge exchange, and heating of the electron gas through photoionization of the heavier elements. In addition, fairly extensive tables of atomic data for the elements considered are included. Values are listed for transition probabilities, collision strengths, and ground-state photoionization cross sections as functions of frequency. (Diss. Abstr. Int., B)

31831 MICROWAVE RADIATION OF WATER VAPOR IN GALACTIC SOURCES. Sullivan III, Woodruff Turner. College Park, Md.; Univ. of Maryland (1971). 125p. University Microfilms Order No. 72-12,857.

Thesis.

1.35-cm $6_{16} \rightarrow 5_{23}$ H_2O emission was observed in the galactic sources W_3, W_3-OH, Ori A, Vy CMa, NGC 6334N, Sgr B2, W49, W51, ON 1, and W75S in nine distinct periods extending from 1969 January to 1970 June. Both the 85-foot antenna of the Naval Research Laboratory at Maryland Point, Md. and the 140-foot antenna of the National Radio Astronomy Observatory at Green Bank, W. Va. were used. The H_2O emission was in general very intense, sometimes as in W49 reaching almost 10^{-21} W m^{-2} Hz^{-1}. Remarkable changes occurred in the complex frequency structure of the H_2O profiles and in the intensity, width, apparent radial velocity, and linear polarization of the individual features. In many cases, as for Sgr B2 and W75S, very intense features entirely disappeared. Typical time scales for these changes ranged from several months to only a few days. No system or periodicity was found in these variations. (TSS) (Diss. Abstr. Int., B)

31832 X-RAY SURVEY OF THE CYGNUS REGION IN THE 20- TO 300-keV ENERGY RANGE. Matteson, James Leland. San Diego, Calif.; Univ. of California (1971). 83p. University Microfilms Order No. 72-13,290.

Thesis.

Cyg X-1 was observed at 20 to 300 keV on June 10, 1969 by a balloon-carried x-ray telescope with 34.2 cm^2 of sensitive area and a 5.9° FWHM field of view. Its spectrum cannot be adequately fit by a single power law, but the power law $dn/dE = 9.8 \times 10^{-2} E^{-0.95}$ photons $(cm^2\text{-sec-keV})^{-1}$ below 83 keV with a break of −1.52 in the spectrum index at 83 keV provides a good fit. Factor two variations occurred on a five-minute time scale at 17 to 31 keV but did not extend to higher energies. On July 17, 1969 the Cygnus region was surveyed with the same instrument. The Cyg X-1 spectrum is fit by the power law $dN/dE = 1.8 \times 10^{-2} E^{-1.0}$. The flux of 24 to 83 keV is a factor seven below that of June 10 and is the lowest measured from Cyg X-1 at these energies. These observations are inconsistent with Dolan's eclipsing binary model of Cyg X-1 and together with other observations in May and June 1969 show that large variations occurred in the spectrum on a time scale of a week. The Cyg X-2 flux, 6.6×10^{-4} photons $(cm^2\text{-sec-keV})^{-1}$ at 24 to 52 keV, confirms the presence of a hard spectrum component above the extrapolation of 1- to 10-keV spectra. The Cyg X-3 spectrum, $dN/dE = 1.1\ E^{-2.2}$, lies below previous measurements and confirms factor ten variations above 20 keV. Upper limits of $\sim 6 \times 10^{-4}$ photons $(cm^2\text{-sec-keV})^{-1}$ at 24 to 52 keV were established for Cyg X-4, the Cygnus Loop, and Cygnus A. (Diss. Abstr. Int., B)

31833 UPPER LIMIT ON THE X-RAY FLUX ASSOCIATED WITH GRAVITATIONAL RADIATION. Baird, G. A. (Simon Fraser Univ., Burnaby, B. C.); Pomerantz, M. A. Phys. Rev. Lett.; 28: No. 20, 1337-40(15 May 1972).

An upper limit in the x-ray flux accompanying pulses of gravitational radiation was determined with relatively simple balloon-borne apparatus. The minimum detectable flux in space, approximately 2×10^{-5} erg/cm^2 event, is about 9 orders of magnitude below the energy flux which produces the gravitational signals observed by Weber. Furthermore, it is lower than that attainable with the much more elaborate and difficult ground-based methods which have been suggested so far. (auth)

31834 UNUSUAL POLARIZATION FEATURE IN PSR 0833-45. McCulloch, P. M. (Univ. of Tasmania, Hobart, Australia); Hamilton, P. A.; Ables, J. G.; Komesaroff, M. M. Astrophys. Lett.; 10: No. 4, 163-5(Apr 1972).

Polarization measurements of PSR 0833-45 at 400 MHz are reported. An unusual polarization feature, namely a very rapid sweep in position angle during the initial phase of the pulse, was observed. (auth)

31835 FORMALDEHYDE ABSORPTION OF SAGITTARIUS A AT +40KM/SEC. Gardner, F. F.; Whiteoak, J. B. (Max-Planck-Institut fuer Radioastronomie, Bonn.). Astrophys. Lett.; 10: No. 4, 171-4(Apr 1972).

An investigation of CH_2O near the galactic center was carried out with a beamwidth of 4.2 arc min and a frequency resolution of 33 kHz (2 km/sec). The +40 km/sec absorption feature was associated with a single continuum component of Sgr A. The positional change with velocity was consistent with rotation about an axis perpendicular to the plane of the Galaxy. (auth)

31836 WHY MANY INFRARED ASTRONOMICAL SOURCES EMIT AT 100 μm. Harwit, M.; Soifer, B. T.; Houck, J. R.; Pipher, J. L. (Cornell Univ., Ithaca, N. Y.). Nature (London) Phys. Sci.; 236: No. 68, 103-4(17 Apr 1972).

Some general features characterizing many galactic sources, as indicated by recent far-infrared observations, are discussed. These strongly suggest that all far-infrared sources are associated with H II regions. Questions arise, however, as to whether spectral line or band emission is involved, or whether thermal emission from grains provides the most likely explanation. The aim of the present communication is to show that line emission alone does not easily fit the facts, but that grains in the outer portions of many H II regions appear to be the prime infrared sources at 100 μm. Evidence was found that the observed emission represents a continuum, rather than narrow-band or discrete-line emission, and it is assumed that the continuum is due to thermal grain emission. Models to explain the grain heating are proposed, based on heating through resonantly trapped Lyman-α photons. (UK)

31837 FLUCTUATIONS IN THE X-RAY INTENSITY OF SCO X-1. Griffiths, R. E.; Cooke, B. A. (Univ. of Leicester, Eng.). Nature (London) Phys. Sci.; 236: No. 68, 104-5(17 Apr 1972).

Rocket observations are reported showing that the 2- to 14-keV x-ray flux from Sco X-1 varies on a time scale of ~1 min. The observational periods were not long enough to determine whether or not the fluctuations were periodic. Previous studies on this topic are also summarized. The fluctuations are interpreted to arise from the mass motions or vibrations of the emitting plasma. (UK)

31838 POSSIBLE IDENTIFICATION OF GX 5-1. Braes, L. L. E.; Miley, G. K.; Schoenmaker, A. A. (Leiden Observatory). Nature (London); 236: No. 5347, 392(21 Apr 1972).

It is stated that previous attempts to identify the x-ray source GX 5-1 have been unsuccessful, but observation of a weak radio point source at the x-ray position is here reported, using the Westerbork synthesis radio telescope operating at 1415 MHz. The flux density was 0.010 ± 0.003 fu. Radio and x-ray positions are given. Positive identification of this radio source with GX 5-1 must await detection of radio variability, and further optical studies are also needed. (UK)

31839 SURVEY OF LINEAR POLARIZATION AT 1415 MHz. I. METHOD OF REDUCTION AND RESULTS FOR THE NORTH POLAR SPUR. Spoelstra, T. A. Th. (Sterrewacht, Leiden). Astron. Astrophys., Suppl. Ser.; 5: No. 3, 205-38(Mar 1972).

The reduction of observations of linear polarization of the galactic background radiation in the direction of the North Polar Spur at 1415 MHz is discussed. The antenna pattern shows some asymmetry. It may be assumed that systematic effects that could be introduced by the observational method can be neglected. The most important effect to correct for is the azimuth- and elevation-dependent spurious polarization. The results are presented in tabular form. (auth)

31840 POSSIBLE MECHANISM OF FORMATION OF THE SPECTRA OF COSMIC X-RAY SOURCES. Gnedin, Yu. N.; Dolginov, A. Z.; Tsygan, A. I. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 10: No. 9, 283-5(5 Nov 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 10: No. 9, 441-4(5 Nov 1969).

In all the models proposed to explain x-ray source spectra it is assumed in essence that the radiation spectrum is an equilibrium spectrum in a medium. Attention is called to the fact that the spectrum of Sco XR-1 is surprisingly similar to the nonequilibrium spectrum of the hard γ radiation, with energy of the order of several MeV resulting from deceleration of gamma quanta in a medium (W.D.M.)

31841 SURVEY OF THE CONTINUUM RADIATION AT 820 MHz BETWEEN DECLINATIONS -7^0 AND $+85^0$. I. OBSERVATIONS AND REDUCTIONS. Berkhuijsen, Elly M. (Leiden Observatory). Astron. Astrophys., Suppl. Ser.; 5: No. 3, 263-312(Mar 1972).

Contour maps of absolute brightness temperature at 820 MHz are presented, being the result of a fully sampled continuum survey with the Dwingeloo telescope. The resolution of the map is 1.2°. Correction for radiation into the antenna sidelobes is made. The random error in the brightness temperatures is ±0.2°K; systematic effects between different parts of the map are smaller than 0.3°K. The absolute zero level is determined from a comparison with horn measurements and has a standard error of ±0.6°K, if the theoretical value of the zenith extinction is assumed to be correct. The temperature scale is known to better than 6%. Polarization percentages are given. (auth)

31842 ARE QUASARS ASSOCIATED WITH BRIGHT GALAXIES? Bahcall, John N. (Inst. for Advanced Study, Princeton, N. J.). McKee, Christopher F.; Bahcall, Neta A. Astrophys. Lett.; 10: No. 4, 147-52(Apr 1972).

A complete sample of 222 quasi-stellar radio source (QSRS) identifications and 166 radio quiet quasi-stellar object (QSO) identifications was studied to look for possible correlations with the positions of bright galaxies. The results were consistent with a random correlation between the positions of quasars and bright galaxies for angular separations less than 30 arc min. (auth)

31843 DETECTION OF INTERSTELLAR RECOMBINATION LINES FROM EMITTERS OF INTERMEDIATE MASS. Chaisson, E. J. (Harvard Coll. Observatory, Cambridge, Mass.); Black, J. H.; Dupree, A. K.; Cesarsky, D. A. Astrophys. J.; 173: No. 3, L131-5(1 May 1972).

The 18-cm microwave spectra of Orion B and W3A show evidence of an emission feature to the high-frequency side of the carbon recombination line. Observations at different frequencies establish that this feature results from electronic recombination. In addition, theoretical considerations, results of 21-cm observations, and computer-simulated spectra suggest that the new feature originates in a predominantly neutral hydrogen region and can be explained by a superposition of recombination lines from any or all of the following elements: ^{24}Mg, ^{28}Si, ^{32}S, and ^{56}Fe. (auth)

31844 OBSERVATIONS OF CS, HCN, U89.2, AND U90.7 IN NGC 2264. Zuckerman, B. (Univ. of Maryland, College Park); Morris, M.; Palmer, Patrick; Turner, B. E. Astrophys. J.; 173: No. 3, L125-9(1 May 1972).

The young cluster NGC 2264 is a rich source of millimeter-wavelength molecular lines and a potentially good candidate for detection of an infrared nebula. Because of the narrow line widths (~3 km s^{-1}) HCN hyperfine structure is resolved. Improved rest frequencies for the unidentified lines U89.2 (X-ogen) and U90.7 ("HCN") were obtained. (auth)

31845 UNUSUAL HIGH-VELOCITY HYDROGEN FEATURE. Wannier, P. (Princeton Univ., N. J.); Wrixon, G. T. Astrophys. J.; 173: No. 3, L119-23(1 May 1972).

21-cm observations were made of an unusual high-velocity feature in the region of the South Galactic Pole. Along a single narrow cloud some 60° in length a systematic variation of the radial velocity is seen in the range -400 km $s^{-1} < V_r < -60$ km s^{-1}. The velocity behavior is suggestive of rigid motion. (auth)

31846 X-RAY EMISSION FROM RICH CLUSTERS OF GALAXIES. Gursky, H. (American Science and Engineering, Cambridge, Mass.); Solinger, A.; Kellogg, E. M.; (and others). Astrophys. J.; 173: No. 3, L99-104(1 May 1972).

The Uhuru catalog has revealed a significant number of rich clusters associated with x-ray sources. Combined with earlier observations of x-ray emission from the Virgo, Coma, and Perseus clusters, this suggests that most, if not all, rich clusters include an x-ray emission region of large size and of net luminosity 10^{43} to 10^{44} ergs s^{-1}. (auth)

31847 OPTICAL CANDIDATES FOR TWO X-RAY SOURCES. Brucato, Robert J.; Kristian, Jerome (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 173: No. 3, L105-7(1 May 1972).

The bright stars X Per and HD 77581 are suggested as possible candidates for the x-ray sources 2U 0352 + 30 and 2U 0900−40, respectively. The first is an active, rapidly rotating Be star which is losing mass. The second is similar to BD + 34°3815, a likely candidate for Cyg X-1, in spectral type and in the possibility that it may be a short-period binary. (auth)

31848 NGC 1068, 3C 273, AND SCORPIUS X-1: CIRCULAR POLARIZATION DISPUTED. Kemp, James C. (Univ. of Hawaii, Honolulu); Wolstencroft, Ramon D.; Swedlund, John B. Astrophys. J.; 173: No. 3, L113-18(1 May 1972).

Null results to within 0.05% were obtained for the circular polarization of NGC 1068 and 3C 273; and similarly for Sco X-1 except possibly on one occasion. (auth)

31849 SEARCHES FOR HIGH-ENERGY GAMMA RAYS FROM PULSARS USING A FAST NIGHT SKY CHERENKOV DETECTOR. Charman, W. N. (Atomic Energy Research Establishment, Harwell, Eng.); Fruin, J. H.; Jelley, J. V.; (and others). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 59-62(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Upper limits were set to possible γ emission from pulsars NP0532, CP0950, CP1133, and HP1506 in the energy region 2×10^{12} eV. Attempts were made to detect both a pulsed flux, using the known radio periods, and a constant flux. (auth)

31850 SEARCH FOR PERIODIC, HIGH-ENERGY GAMMA RAYS FROM PULSARS. Charman, W. N. (Atomic Energy Research Establishment, Harwell, Eng.); Jelley, J. V.; Drever, R. W. P. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 63-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Observations were made on four pulsars, using a night-sky Cherenkov light receiver with an estimated energy threshold of about 1.3×10^{13} eV for proton showers arriving from near the zenith. Sources were tracked continuously and the times of arrival of showers within the field of view were recorded on magnetic tape together with a 500 Hz reference time signal derived from a crystal oscillator. Subsequent playback of the tapes into a multichannel analyzer cycled at the appropriate pulsar period, as determined by radio observations, allows upper limit to be set on the pulsed emission of γ rays from the sources. (auth)

31851 ACCELERATION OF HIGH-ENERGY COSMIC RAYS BY PULSARS. Ostriker, J. P. (Princeton Univ., N. J.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 69-78(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Very large quantities of low-frequency electromagnetic radiation will be produced by the rotating, magnetic, neutron stars favored for pulsar models. It is shown that this radiation can accelerate particles injected into the wave field to energies in excess of 10^{18} eV (adopting parameters derived from the Crab object); the computed spectral dependence accords with cosmic-ray observations; and the total energy available is consistent with the observed density of these very high-energy particles. The maximum energy a proton can attain by this mechanism is of order $(e^2/Gm_p^2)^{1/4}$ × rest mass or ~10^{21} eV. By the same acceleration mechanism the common white dwarf stars are able to produce 10^{11} to 10^{14} eV particles having an abundance distribution consistent with the observed galactic cosmic rays. (auth)

31852 OBSERVATION OF GAMMA RADIATION FROM THE CYGNUS REGION OF THE GALACTIC DISC. Hutchinson, G. W.; Pearce, A. J.; Ramsden, D.; Wills, R. D. (Univ. of Southampton, Eng.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 87-92(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A gamma-ray telescope incorporating an acoustic spark chamber is included in the payload of the OGO-5 spacecraft. The instrument is sensitive to photons of energy above 25 MeV. The observations, which are limited to a portion of the sky near Cygnus indicate a variation of intensity showing a maximum in a direction close to the galactic plane. If this plane contains a line source of radiation, its intensity is found to be $(4.9 \pm 2.1) \times 10^{-4}$ photons cm^{-2} s^{-1} rad^{-1} above an energy of 40 MeV. No point sources were detected, giving an upper limit of 1.4×10^{-4} cm^{-2} s^{-1} on the intensity of photons above 40 MeV from Cygnus XR-1. (auth)

31853 GAMMA-RAY ASTRONOMY RESULTS AT BALLOON ALTITUDES. Kniffen, D. A.; Fichtel, C. E.; Oegelman, H. B. (Goddard Space Flight Center, Greenbelt, Md.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 93-9(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Results of several balloon flights of a digitized gamma-ray spark chamber have failed to detect a point source of gamma rays greater than 30 MeV. Upper limits to the fluxes emitted by possible discrete sources are presented. A scan of the galactic center region gives a line intensity of $(2.3 \pm 1.2) \times 10^{-4}$ γ $(cm^2$ sec $rad)^{-1}$ above 100 MeV for galactic latitudes of $-3°$ to $+3°$. Although this result does not justify a claim of a positive result, it is consistent with the OSO-III measurement of $4.1 \pm 0.7 \times 10^{-4}$ γ $(cm^2$ sec $rad)^{-1}$. The intensity, energy spectrum, and zenith angle dependence of the atmospheric gamma rays were also measured. The observed downward intensity is in reasonable agreement with other measurements; however, the upward moving intensity >100 MeV is a factor of about 3 lower than the OSO-III result. Preliminary results from a July 1969 balloon flight of a new 50 cm by 50 cm spark chamber gamma-ray telescope are presented. The results do not indicate a detectable line intensity in the galactic longitude interval $142.5° \leq l^{II} \leq 194.0°$ with a 95% confidence limit of 2.3×10^{-4} γ $(cm^2$ sec $rad)^{-1}$ for $-3° \leq b^{II} \leq 3°$ and 5.4×10^{-4} γ $(cm^2$ sec $rad)^{-1}$ for $-15° \leq b^{II} \leq 15°$ for gamma rays with energies above an estimated 100 MeV. The detector sensitivity should have been sufficient to measure the line intensity in this region at the reported OSO-III level though the disagreement is only one standard deviation. (auth)

31854 SEARCH FOR PERIODIC GAMMA-RAY EMISSION IN THE 10^{11}- TO 10^{13}-eV ENERGY REGION FROM PULSARS. Fazio, G. G. (Smithsonian Astrophysical Observation, Cambridge, Mass. Harvard Coll., Cambridge, Mass.); Hearn, D. R.; Helmken, H. F.; Rieke, G. H.; Weekes, T. C. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 111-14(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The 10-m optical reflector at Mt. Hopkins, Arizona, was used to search for cosmic gamma radiation from pulsars by the detection of Cherenkov light generated in the atmosphere by energetic-particle showers. In the energy region 10^{11} to 10^{13} eV, evidence of periodic gamma emission was found from the five pulsars investigated: NP 0532, CP 1133, CP 0328, CP 0950, and AP 1541 + 09. Upper limits to the flux from these sources are given. (auth)

31855 UPPER LIMITS TO THE EMISSION OF 10^{11}-eV GAMMA RAYS FROM DISCRETE SOURCES. Fazio, G. G. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll., Cambridge, Mass.); Helmken, H. F.; Rieke, G. H.; Weekes, T. C. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 115-21(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The 10-m optical reflector at Mt. Hopkins, Arizona, has been used to search for cosmic gamma rays by the detection of atmospheric Cherenkov radiation from energetic-particle showers. Approximately 100 drift scans of the Crab Nebula during 1968–1969 yielded no positive evidence of a gamma-ray flux. The upper limit to the flux at an energy of 1.7×10^{11} eV is 2.0×10^{-10} photons cm^{-2} sec^{-1}. Assuming a synchrotron model for the Crab Nebula and Compton scattering by the relativistic electrons, a lower limit on the average magnetic field in the Nebula is 1.5×10^{-4} gauss. Similar upper limits to the gamma-ray fluxes from M 87, M 82, Sagittarius A, and 23 other sources, such as supernova remnants, pulsars, magnetic variables, x-ray sources, galaxies, and quasars are given. (auth)

31856 OBSERVATIONS OF SCO X-1 X-RAY SOURCE IN THE RANGE 16 TO 111 keV. Agrawal, P. C.; Biswas, S.; Gokhale, G. S.; (and others) (Tata Inst. of Fundamental Research, Bombay). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 1, 277-81(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The properties of Sco X-1 were studied in the energy interval 16 to 111 keV using balloon-borne x-ray detectors. The x-ray telescope consisted of a NaI(Tl) crystal with an area of 97.3 cm^2 and 4 mm thick surrounded by cylindrical active and passive collimators with a field of view of 18.6° FWHM. The telescope was mounted on an orienting platform with its axis at 31° to the zenith and it scanned an annulus in the sky in each rotation. The balloon flight was made from Hyderabad on April 16, 1969. The data obtained from this flight were combined with those from the earlier flights on April 28, 1968 and December 22, 1968 using the same instrument. It was found that in the energy interval 16 to 111 keV, the spectrum can be represented either (i) by the exponential form $N(E)dE = (K/E)e^{-E/E_0}dE$ with $E_0 = 5$ keV, in the energy range 15 to 40 keV, and $E_0 \approx 30$ keV in the 40 to 110 keV range, or (ii) by a power spectrum of the form $N(E)dE = C.E^{-\alpha}$, where $\alpha = 4.5 \pm 0.5$ over the entire energy range. The flux in the energy interval 16 to 47 keV was found to be almost steady for a period of one hour on April 16, 1969. (auth)

31857 NEW PULSAR-SUPERNOVA ASSOCIATION. Large, M. I.; Vaughan, A. E. (Univ. of Sydney). Nature (London) Phys. Sci.; 236: No. 69, 117-20(24 Apr 1972).

It is stated that a recent measurement of the declination of the pulsar PSR 1154-62 places it near the galactic radio source G.296.8-0.3, which has the shell structure and spectrum characteristics of a supernova remnant, and although the pulsar lies just outside the boundary of this source, the distance estimates are compatible, and physical association is possible if there is a mutual velocity of ~560 km/S. The possibility that the pulsar and the supernova remnant are associated is here discussed. The supernova remnant is the first to be recognized in the Constellation of Crux and is here referred to as the Crux supernova; it has a low total radio power and surface brightness, is old, and has a large diameter. Observational data for PSR 1154-62 obtained at 408 MHz with the Molonglo radio telescope are presented. The possibility of chance associations is discussed, and also implications of the Crux supernova–pulsar association. (UK)

31858 COLOURS AND RED SHIFTS OF QUASARS. Goldsmith, S. (Univ. of Tel-Aviv, Israel). Nature (London) Phys. Sci.; 236: No. 69, 122-3(24 Apr 1972).

In the catalogue of quasars published by de Veny and others (Publ. Astronom. Soc. Pacific, 83: 611(1971)) colors are given for 130 objects. The present authors used these data to check correlations between color indices and redshift, and the conclusion of Strittmatter and Burbidge (Astrophys. J., 147: 13(1967)) that redshifts cannot be reliably determined from the colors was further established, although in some cases a reasonable value of z can be estimated. (UK)

Solar Phenomena

Refer also to abstracts 31754, 31956, and 31976.

31859 (AD–734937) DIVERS SOLAR ROTATIONS. Wilcox, John M. (Stanford Univ., Calif. Inst. for Plasma Research). Oct 1971. Contract N00014-69-A-0200-1049. 10p. (SU-IPR-441). NTIS.

An interesting variety of rotational properties in the photospheric and solar-wind plasma and magnetic fields is discussed. (NTIS)

31860 (CERN–71-16(Vol.1 and 2), pp 463-83) FLUX AND ENERGY SPECTRA OF SOLAR PROTONS MEASURED IN 1968–69 ON BOARD THE SATELLITE ESRO II. Engelmann, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). (In French).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

Data are presented on the following: counting rates for Nov. 17, 1968, sixteen hours before proton flare and on Nov. 18, 1968, eight hours after the flare; differential energy spectra of 10 proton flares from June 9, 1968 through Feb. 27, 1969 from 25 to 280 MeV; integral intensities of >30 MeV and >100 MeV of the 10 flares above; time–intensity profile at 5 energies (30, 38.5, 53, 79, and 170 MeV) for the Nov. 18, 1968 event; differential energy spectra for 7 times (from 1 h, 30 min to 77 h) after the Nov. 18, 1968 event and rigidities for these times; and values as a function of time of the indices R_0 and γ for the rigidity spectra above, on the basis of the magnetic index K_p. (L.M.T.)

31861 (TRITA-EPP-72-4) SAILING ON THE SOLAR WIND. Fahleson, Ulf (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Feb 1972. 16p. Dep. NTIS (U. S. Sales Only).

The realization of successful missions to the outer planets and beyond depends critically upon the development of suitable methods of accelerating space vehicles in sufficiently short times to sufficiently high velocities. A useful power source may be available after the development of direct extraction of electrical energy from nuclear reactions. Until then, plasma propulsion engines have to be supplied with energy from sources outside the vehicle. The report discusses the principles for using solar wind for propulsion of space vehicles, but it is presently impossible to give a definite statement about the feasibility of "solar wind sailing." (Sweden)

31862 PROCESSES OF ENERGY TRANSPORT BY LONGITUDINAL WAVES AND THE PROBLEM OF SOLAR NEUTRINOS. Littleton, J. E.; van Horn, H. M.; Helfer, H. L. (Univ. of Rochester, N. Y.). Astrophys. J.; 173: No. 3, 677-9(1 May 1972).

Energy transport by longitudinal plasma waves in the Sun is shown to contribute less than $\sim 5 \times 10^{-5}$ of the total energy flux and is thus insufficient to explain the solar-neutrino problem. (auth)

31863 SOLAR SPECTRUM 2100 TO 3200 A. Broadfoot, A. Lyle (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J.; 173: No. 3, 681-9(1 May 1972).

The spectral irradiance of the Sun between the wavelengths of 2100 and 3200 Å was measured with a spectrometer from a stabilized Aerobee rocket. Previous spectra are in generally good agreement with these new measurements. A significant difference was found in the 2500 to 2600 Å region which, in the interpretation of planetary atmospheres, could be mistaken for a small amount of ozone. (auth)

31864 HEAVY IONS FROM INTERPLANETARY DUST. Nakada, M. P. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 77: No. 10, 1713-19(1 Apr 1972).

Most atoms that are evaporated from interplanetary dust near the Sun are quickly ionized and are probably carried away by the interplanetary magnetic field and the solar wind. The contribution of these heavy ions to the solar-wind flux has been estimated by using estimates of the mass required to maintain the zodiacal cloud. This contribution appears to be small compared with the heavy-ion flux of coronal origin. Many ions from dust remain singly ionized; some of these, such as Ca^+, can resonantly scatter solar radiation. The contribution of this interplanetary glow to the background of twilight glow has been estimated. Interplanetary glow may be detectable. Some atoms from dust may be accelerated by radiation pressure before being ionized. Estimates of velocities and fluxes for Fe indicate that this acceleration is not very effective. (43 references) (auth)

31865 MATHEMATICAL ANALYSIS AND INTERPRETATION OF THE SOLAR CORONA. Calbert, Roosevelt. Lawrence, Kan.; Univ. of Kansas (1971). 157p. University Microfilms Order No. 72-11,736.

Thesis.

For dust scattered light this work: (1) makes a detailed computer calculation of the dust scattered light at small elongations (1.5 to 10 solar radii) and allows for predictions of the radial dust distribution; (2) allows for the study of the particle radius and concentration; (3) calculates the reflection component with similar parameters to those used in the diffraction calculations; (4) predicts a possible minimum distance for the dust from the Sun due to temperature effects and radiation pressure; and (5) describes the possible role of the gegenschein in dust scattered light near the Earth. A mathematical technique is devised whereby the solar corona may be separated into electronic and dust scattered components. Various scientific studies of electron distribution in the corona are reviewed. An analysis is made from coronal experimental data received from a balloon flight engineered by McQueen and Strong. (TSS) (Diss. Abstr. Int., B)

31866 OBSERVATIONS BY BALLOON OF THE SOLAR SPECTRA AT 1.85 μ WITH RESOLVING POWER OF 135,000. Zander, R. (Univ., Liege). Bull. Cl. Sci., Acad. Roy. Belg.; 56: No. 7, 729-39(1970). (In French).

On April 6, 1970, the Institute of Astrophysics, Liege Univ., launched a stratospheric balloon transporting a telescope with 40-cm aperture and a grating spectrometer of the Ebert–Fastie type of 2.5 m focal length. The solar spectra obtained in the H_2O band centered at 1.87 μ, with a spectral resolution of .04 cm^{-1}, permitted 60 solar lines between 5480.0 and 5382 cm^{-1} and for the most part not identified before, to be determined with high precision. Study of the absorption of the telluric water vapor indicated that the stratosphere is dry, with a moisture content of the order of 2×10^{-6} gg^{-1}; the possibility of an increase in the content above 40-km altitude is not excluded at this stage of development of the data. (auth)

31867 PLASMA PHENOMENA IN ASTROPHYSICS. Falthammar, C.-G. (Royal Inst. of Tech., Stockholm). pp 1-35 of Phenomena in Ionized Gases, 1971. /Davenport, P. A. (ed.). Oxford; Donald Parsons and Co. Ltd. (1971).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

After a brief introduction to the subject the following topics are discussed. Distribution of plasma in space (ionosphere; magnetosphere; interplanetary plasma; solar wind; solar corona; chromosphere; photosphere; the sun itself; stellar winds; interstellar H II regions; H I regions); classification of plasma; ionospheric plasma processes (elementary model of the production function; elementary theory of diffusion equilibrium; processes determining ionospheric composition; thermal conditions; ionospheric disturbances); wave phenomena in the magnetosphere (ducted whistlers; other vlf phenomena; micropulsations; Alfvén waves observed in situ); auroras and magnetic storms (auroral precipitation; magnetospheric substorms, magnetic-field-aligned potential drops); diffusion and acceleration of trapped particles; interaction of interplanetary plasma with the magnetosphere; interplanetary plasma (solar wind); plasma phenomena in the Sun and stars, and interstellar and intergalactic space. 88 references. (UK)

31868 SUN AS A MAGNETIC ROTATOR. Tuominen, Jaakko (Univ. of Helsinki). Astrophys. Lett.; 10: No. 4, 175-7(Apr 1972).

Counts of newly formed sunspot groups indicate that the long-lasting magnetic fields of the Sun as a whole, which have been observed by Severny, represent fields of the following components of sunspot groups and magnetic regions dispersed over large areas. (auth)

31869 EFFECT OF SECONDARY AUTOIONIZATION ON DIELECTRONIC RECOMBINATION. Blaha, M. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. Lett.; 10: No. 4, 179-82(Apr 1972).

During the process of dielectronic recombination, the energy of a recombined ion after a resonance capture and subsequent stabilization may still be higher than the first ionization limit. If that happens, a secondary autoionization can take place and reduce the recombination coefficient. The importance of this effect is considered for iron ions Fe X to Fe XIV. (auth)

31870 COMET-LIKE INTERACTION OF VENUS WITH THE SOLAR WIND. I. Wallis, Max K. (Royal Inst. of Tech., Stockholm). Cosmic Electrodyn.; 3: No. 1, 45-59(Apr 1972).

Clear differences of the plasma flow past Venus from that outside the magnetosphere—in particular, absence of an upstream bow shock and of an extended ionospheric tail—characterize the Venus–solar wind interaction. Using data of the Venus probes, the interaction is interpreted here from the point of view of ion creation in an extended Venusian atmosphere, similar to the outer coma of comets. The new ions both decelerate the solar wind and themselves gain large energies. A helium upper atmosphere with standard density ($10^{7.5}$ cm^{-3} at 200 km) but high temperature around 1500°K would fit the observations. Helium ions created out in the exosphere and accelerated generally inwards by the interplanetary fields should produce this hot atmospheric component. The total ionization rate is suitably large to support the theory of He^+ in the nightside ionosphere. Although most of the helium ions may be neutralized after transport into the lower atmosphere, the loss rate to the solar wind is still large: it should on the average equal the radiogenic production rate. (auth)

31871 DYNAMICS OF THE AZIMUTHALLY DEPENDENT SOLAR WIND. Matsuda, Takuya (Kyoto Univ.); Sakurai, Takeo. Cosmic Electrodyn.; 3: No. 1, 97-115(Apr 1972).

The dynamics of the steady, rotating, azimuthally-dependent solar wind under the influence of a magnetic field is considered. The formation of the arm-like structure striated along the spiral configuration of the solar wind by the nonlinear steepening effect of the compressive part was shown analytically by a previously proposed quasi-radial hypervelocity approximation (QRH approximation). Numerical calculations based on the newly proposed hypervelocity approximation (H-approximation), which includes the convective terms due to the azimuthal component of the solar-wind velocity are performed. The typical sawtoothed shape of the azimuthal distributions of radial velocity and spiked configurations of density and magnetic field near the orbit of the Earth are obtained on the basis of purely sinusoidal distributions at 30 $R_\odot$. (auth)

31872 RADIAL DEPENDENCE OF ELECTRON TEMPERATURE IN TWO-FLUID MODELS OF THE SOLAR WIND. Weber,

E. J. (Kitt Peak National Observatory, Tucson, Ariz.). Cosmic Electrodyn.; 3: No. 1, 116-18(Apr 1972).

It has been assumed on two-fluid models that the electron gas energy equation is heat-conduction-dominated, which implies that the electron temperature will decrease like $r^{-2/7}$. It is pointed out here that this is an incorrect assumption and that even if the heat conduction is very large the electron temperature has to decrease like $r^{-4/7}$, resulting in a lower value at the orbit of Earth that is closer in accord with observations. (auth)

31873 BALLONNAYA ASTRONOMIYA. (Balloon Astronomy). Krat, V. A.; Kotlyar, L. M. Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1972). 89p.

The history of balloon observation is reviewed, with descriptions of the types of equipment used in making observations in the upper reaches of the atmosphere. Problems that have been successfully solved by balloon astronomy, together with instruments and methods, are briefly discussed. These include the structure of the solar photosphere, the presence of deuterium in the Sun, infrared radiation, and an investigation of the Seyfert galaxy NGC 4151. (K.S.W.)

31874 SHOCK WAVES AND MAGNETIC FIELD CONFIGURATION IN INTERPLANETARY SPACE. Korobeinikov, V. P.; Nikolayev, Yu. M. Cosmic Electrodyn.; 3: No. 1, 25-44(Apr 1972).

The gas-dynamical approximation was used to calculate the formation and propagation of strong shock waves in interplanetary space after chromospheric flares. The initial parameters of the interplanetary medium (pressure, density, velocity) may be approximately represented by a power law dependence of the radial coordinate. The dynamics of solar-wind pressure after a flare may be described in terms of the blast-wave model and coronal gas expansion in accordance with a power-law piston model. A combination of these simple models is also possible. At first a point explosion occurs, then a piston expands from the explosion point, the velocity being decelerated according to the power law. Other formulations of the problem are possible that would involve various physical effects (deposition of energy, injection of solar particle into the gas flow field, gravity, etc.). The accurate analytical solution of the problem of the propagation of a strong shock wave in a medium, the density of which varies in inverse proportion to the square of the distance, was obtained in the approximation of the point explosion model, including the velocity and initial pressure of the interplanetary plasma. A numerical solution of the piston problem was obtained. The effect of a weak magnetic field on the gasdynamics is not taken into account but, proceeding from the condition of a frozen-in field, the configurations of the magnetic field have been determined. The space-vehicle observational data were analyzed and interpreted physically. The theoretical results are compared to some results of experimental plasma measurements in interplanetary space. (auth)

Galaxies

Refer also to abstracts 31846 and 31848.

31875 GALACTIC EVOLUTION. I. DIFFERENTIAL EFFECTS OF RADIATION PRESSURE AROUND STARS OF DIFFERENT SPECTRAL TYPES ON NEUTRAL ATOMS AND DUST GRAINS. Pecker, J.-C. (College de France, Paris. Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Astron. Astrophys.; 18: No. 2, 253-66(May 1972). (In French).

The ratios, and actual values, for forces exerted both by radiation pressure and gravitation on atoms of H I, He I, C I, Fe I, Eu I, and on dust grains of various sizes are computed, at a large distance from the star, for stars of all spectral types (assuming that the medium is essentially neutral, and that atoms are in the ground state) and for a schematic galaxy. Clearly, the effects of gravitation and radiation act in such a way as to produce a definite difference in the dynamics of different atomic species and of dust grains of different sizes. A sorting of metals from hydrogen is suggested; first, hydrogen would be strongly expelled; next, hydrogen would be less strongly expelled, whenever metals would not follow; finally, hydrogen would fall again, as dust would. Expulsion would be mostly polar; subsequent partial return of matter would be mostly equatorial. The study of this dynamical behavior will be described in subsequent papers. (auth)

31876 EMISSION-LINE VELOCITY FIELD IN M82. Heckathorn, Harry M. (Northwestern Univ., Evanston, Ill. Manned Spacecraft Center, Houston, Tex.). Astrophys. J.; 173: No. 3, 501-27(1 May 1972).

A slit-spectrum study of the apparent velocity field in the peculiar galaxy M82 (NGC 3034) was completed. Velocity curves were measured from the emission lines of Hα, [N II], and [S II] on 20 spectra obtained by using fiber-optic image intensifiers, and a contour map of the emission-line velocity field was constructed. The observations were interpreted from the standpoint that either (1) the radiation which seen in the direction of the filamentary structure is intrinsic to the filaments or, more likely, (2) the radiation originates at the apparent optical nucleus and is subsequently scattered by dust in the filaments. The conclusion was reached that the ejected material, which is probably expanding away from the central region of the galaxy, must have velocity components that are not directed radially with respect to the apparent optical nucleus. The observations imply that the expanding cloud of ejecta is rotating about an axis roughly perpendicular to the fundamental plane of the galaxy even at distances as large as 45 arc seconds from the apparent nucleus of the galaxy. (auth)

31877 RANDOM GRAVITATIONAL ENCOUNTERS AND THE EVOLUTION OF SPHERICAL SYSTEMS. III. HALO. Spitzer, Lyman Jr.; Shapiro, Stuart L. (Princeton Univ., N. J.). Astrophys. J.; 173: No. 3, 529-47(1 May 1972).

Accumulation of stars in the halo of a spherical stellar system, together with escape of stars from the system, result from stellar encounters within a dense central core; the resultant halo structure is studied both analytically and numerically for an isolated system. On the assumption that conditions in the central core remain constant with time, a simple steady-state solution is obtained for the outermost halo, or "fringe," defined as the region from which stars may escape after a few additional orbits through the central core of the system. In this steady-state solution the density in phase space, f(E, J), obtained from a simple integral equation for the fringe region, is found to vary nearly linearly with E, for E less than the energy of escape E_e; E and J are the energy and orbital angular momentum of a star per unit mass. The flux of stars into the fringe, which about equals the rate of escape from the system, is regarded as an arbitrary constant, F_J, for stars of each J-value; F_J is determined by the evolution of the system as a whole rather than by conditions within the halo. In the particular case of an isolated system, where the escape energy is zero, this steady state cannot be reached for E arbitrarily close to zero since the total number of the stars in the halo would become infinite, but is reached more and more closely as N, the number of stars in the system, increases. The density distribution in this steady state, which should be very nearly reached in practice for N sufficiently large, varies as $1/r^{3.5}$ out to the radius r where the escaping stars give a density varying as $1/r^2$. Monte Carlo runs for somewhat more realistic but isolated clusters confirm that the simple steady-state solution gives a reasonable approximation to the general structure of the halo. (auth)

31878 ROOT MEAN SQUARE FLUCTUATION OF A WEAK MAGNETIC FIELD IN AN INFINITE MEDIUM OF HOMOGENEOUS STATIONARY TURBULENCE. Low, B.-C. (Univ. of Chicago). Astrophys. J.; 173: No. 3, 549-55(1 May 1972).

Generation of a magnetic field by statistically homogeneous, stationary velocity turbulence is considered. The generation of rms magnetic fluctuation is explicitly demonstrated in the limit of short turbulence correlation time. It is shown that the fluctuation $\langle \delta B^2 \rangle$ associated with a growing or stationary mean field $\langle B \rangle$ grows with time such that $\langle \delta B^2 \rangle / \langle B \rangle^2$ tends to a steady value, which is a monotonically decreasing function of the growth rate of $\langle B \rangle$. As an application, $\langle \delta B^2 \rangle / \langle B \rangle^2$ is estimated to be of order one for the galactic medium, in agreement with observational results. In the case of a decaying $\langle B \rangle$, it is shown that the associated $\langle \delta B^2 \rangle$ eventually decays in time, proceeding at a rate slower than that of the decay of $\langle B \rangle$. (auth)

31879 GALACTIC SHOCK IN AN INTERSTELLAR MEDIUM WITH TWO STABLE PHASES. Shu, Frank H. (State Univ. of New York, Stony Brook); Milione, Vincenzo; Gebel, William; (and others). Astrophys. J.; 173: No. 3, 557-92(1 May 1972).

Quasi-steady flows of interstellar gas in a spiral gravitational field are followed for the purpose of investigating galactic shocks and the resultant processes of the formation of stars and interstellar clouds. The interstellar medium is modeled with two stable phases in which thermal balance is maintained through heating by low-energy cosmic rays. The problem, including transitions between the two phases, is given a general formulation but is solved in an approximation which ignores the difference in fluid velocities of the two phases. It is also assumed that the cosmic-ray flux is uniform in circles about the center of the Galaxy and that the relative abundances of the chemical elements are "normal." For a spiral gravitational field with strength equal to 5% that of the axisymmetric field at 10 kpc from the galactic center, the density ratio at maximum and minimum compressions is 9:1 for the intercloud medium while it is 40:1 for the gas in a typical cloud. During the decompression phase of the flow, a small percentage of the mass of the clouds evaporates to become intercloud material, but this small amount is recovered in the shock. As a by-product of phase transitions, the properties of the clouds in the regions between spiral arms are such as to make their detection in 21-cm absorption very difficult. In the absence of the cloud phase, the thickness of the shock layer in the intercloud medium is determined to be typically 50 pc. An interstellar cloud immersed as a test particle in the intercloud medium experiences a dynamic rather than a quasi-static compression as it passes through the shock layer. The critical mass for the gravitational collapse of a cloud is reduced by a large factor because of the compression in the shock. (auth)

31880 IONIZATION EQUILIBRIA OF CALCIUM AND SODIUM IN INTERSTELLAR CLOUDS. Brown, Robert L. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 173: No. 3, 593-9(1 May 1972).

Variations in the ionization equilibria for calcium and sodium as a function of position in interstellar clouds are calculated, including effects due to attenuation of the ultraviolet ionizing radiation by dust grains. It is found that while the ionization rates for Ca, Na, and Ca^+ may vary by more than an order of magnitude within particular clouds, the ratio of number densities $n(Ca^+)/n(Na^0)$ does not exhibit such large variations. Possible influences on this ratio due to cosmic-ray ionization and the charge-transfer reaction $Na + C^+ \rightarrow Na^+ + C^*$ are considered. Some improvement in the agreement between the theoretical ratio and the observed average $n(Ca^+)/n(Na^0) \simeq 0.87$ is evident over calculations in which ultraviolet extinction is neglected, but a significant discrepancy remains. Several effects which would lower the theoretical ratio still further are briefly discussed. (auth)

31881 STABILITY OF WEAKLY IONIZED D-TYPE WAVES IN THE CASE OF AN OPTICALLY THICK LAYER OF IONIZED GAS BEHIND THE FRONT. Krasnobaev, K. V. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 6, 12-16(Nov-Dec 1971). (In Russian).

Ionized fronts in an interstellar medium are characterized by a sharp transition from a state of almost complete hydrogen ionization to the neutral atomic state, which may arise during an expansion of an H II region, during stellar flare-up, or during the motion of interstellar gas relative to the sources of ionizing radiation. It is shown that a stable oscillation is possible. For characteristic parameters of interstellar gas, viscous effects may render a stabilizing influence only on the short-wave disturbances from the long wave length $L \ll L_0$ (L_0 corresponds to neutral oscillations). (tr-auth)

31882 HYDRODYNAMICAL EQUATIONS FOR A COLLAPSING OBJECT WITH SPHERICAL SYMMETRY IN TERMS OF THE SCALAR-TENSOR THEORY OF GRAVITY. Nariai, Hidekazu (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 3, 832-44(Mar 1972).

Because of a possible relevance of the scalar–tensor theory of gravity to the problem of gravitational collapse, an attempt is made to cast the Brans–Dicke field equations for a gaseous sphere without energy flow into the Lagrangian hydrodynamical equations, in comparison with their general relativistic counterparts due to Misner and Sharp. As regards the exterior solution, the Brans solution of Type I is adopted because of its resemblance to the Schwarzschild solution in general relativity. The junction conditions at the stellar surface are also set up, which consist of the previous ones and the other two concerning the inertial scalar and its first derivatives. The presence of the inertial scalar makes a simple generalization of Misner–Sharp mass function useless (because its boundary value cannot be constant in time), so that a new mass function is introduced in a heuristic manner. In order to show its appropriateness, the gravitational collapse of a fluid sphere with uniform density, uniform scalar and negligible pressure corresponding to the Oppenheimer–Snyder model in general relativity is dealt with, in spite of the fact that it violates one (concerning the first derivatives of the inertial scalar) of the junction conditions. Several points to be noticed in the numerical analysis of the hydrodynamical equations are also touched upon. (auth)

31883 RAPID CHANGE IN THE VISIBILITY FUNCTION OF THE RADIO GALAXY 3C 120. Shaffer, D. B. (Owens Valley Radio Observatory, Pasadena, Calif.); Cohen, M. H.; Jauncey, D. L.; Kellermann, K. I. Astrophys. J.; 173: No. 3, L147-50 (1 May 1972).

Second-epoch observations of the radio galaxy 3C 120 ($z = 0.033$) with the Goldstack interferometer show apparent rapid changes in structure similar to those observed for the quasars 3C 273 and 3C 279. The apparent transverse expansion velocity is 2 or 3 times the velocity of light. Earlier observations of 3C 84 and VRO 42.22.01 are confirmed. (auth)

31884 ABSORPTION-LINE SEYFERT GALAXY MARKARIAN 231. Adams, Thomas F. (Univ. of Arizona, Tucson); Weedman, Daniel W. Astrophys. J.; 173: No. 3, L109-11(1 May 1972).

The Seyfert galaxy Markarian 231 has strong and broad emission lines that yield a tentative redshift of 0.041 if the lines are Hα, Hβ, and permitted Fe II. Very strong absorption lines can be identified as the Na I D-lines, Ca II H and K, and He Iλ3889 with a redshift of 0.027. Overall the spectrum resembles that of some absorption-line QSOs in that the absorption lines have multiple components. (auth)

31885 ORIGIN AND FORM OF THE GALACTIC MAGNETIC FIELD. I. PARKER'S DYNAMO MODEL. Piddington, J. H. (CSIRO, Sydney). Cosmic Electrodyn.; 3: No. 1, 60-70(Apr 1972).

Parker's dynamo theory of the galactic magnetic field is examined with the conclusion that it fails for a number of reasons. The main ones are (a) the required merging and cancellation of opposing fields of dimensions ~100 pc in times of 2×10^8 yr is impossible; (b) field merging at the rate needed would require all fields randomized to a scale $\lesssim 2$ pc, which is contrary to observations; (c) much of the observed "turbulence" on which the theory is based is probably oscillatory, and so does not contribute to dynamo action; (d) newly created dynamo field elements lie farther from the galactic plane than old elements, so that the whole galactic field would be lost within a limited number of generations; (e) observational evidence suggests that a field could not be gravitationally contained within the disk, as required. By the same arguments, the field must have been frozen into the Galaxy at the time of its creation, and must have evolved steadily largely as a result of differential rotation. This is the basis of a model developed previously. (auth)

Cosmology

Refer also to abstracts 31793, 31882, 32128, and 32237.

31886 REDSHIFT-DISTANCE RELATION. I. ANGULAR DIAMETER OF FIRST-RANKED CLUSTER GALAXIES AS A FUNCTION OF RED-SHIFT: THE APERTURE CORRECTION TO MAGNITUDES. Sandage, Allan (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 173: No. 3, 485-99(1 May 1972).

Micrometric estimates of the apparent angular diameters of first-ranked elliptical galaxies in clusters, obtained from a homogeneous series of plates taken with the Palomar 48-inch (122 cm) Schmidt and the Hale reflector, are tightly correlated with redshift, such that $\theta_s \sim z^{-1}$. The cosmic dispersion about the mean correlation is $\sigma(\Delta \log \theta) \simeq 0.07$, which is close to $\frac{1}{5}\sigma(\Delta V)$, where ΔV is the deviation of apparent magnitude of these same galaxies from the Hubble diagram. This relation suggests constant mean surface brightness for first-ranked ellipticals, as does correlation of the individual magnitude and diameter residuals. The theoretical $\theta = f(z, q_0)$ relations derived for Friedmann models show that q_0 may eventually be found from accurate microphotometry of such plates (or direct photoelectric area scanning). The predicted differences in the diameter function for various q_0 values are adequately large compared with the intrinsic dispersion $\sigma(\Delta \log \theta)$ for test galaxies at $z > 0.4$ to make such a program feasible. The growth curve of magnitude with measuring aperture is obtained from new photoelectric data listed in Papers II and III. The aperture correction follows from this formulation as a function of z and q_0 alone for first-ranked ellipticals. A method for differential correction of the aperture function is developed that takes account of cosmic differences in intrinsic diameters and different q_0 values. (auth)

31887 NONEXISTENCE OF BARYON NUMBER FOR STATIC BLACK HOLES. Bekenstein, Jacob D. (Princeton Univ., N. J.). Phys. Rev., D; 5: No. 6, 1239-46(15 Mar 1972).

Wheeler has conjectured that black holes should have no well-defined baryon number, and that as a result the law of conservation of baryons should be transcended in black-hole physics. It is shown that a static black hole cannot have any exterior classical scalar or massive vector fields. The modifications that would arise from a quantum-theoretical treatment are considered, and it is concluded that such a black hole cannot interact with the exterior world via virtual mesons such as the π and ρ. Because of this no way is found for external measurements to assign unambiguously a baryon number to such a black hole in agreement with Wheeler's prediction. (auth)

31888 DYNAMICS OF A ROTATING GASEOUS ELLIPSOID IN AN EXPANDING UNIVERSE. Nariai, Hidekazu; Fujimoto, Mitsuaki (Hiroshima Univ. Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 47: No. 1, 105-17(Jan 1972).

In order to assess the importance of the coupling of vorticity with the cosmic expansion in the process of galaxy formation, dynamical equations for a rotating gaseous ellipsoid with uniform density embedded in an expanding Universe were derived on the basis of Newtonian hydrodynamical equations rewritten so as to be useful in a rotating frame of reference relative to the cosmological one. Numerical integrations of the equations were carried out on gaseous ellipsoids of the initial density $\rho = 1.2\,\rho_B$, $1.1\,\rho_B$, and $1.05\,\rho_B$, where ρ_B is the background density of the expanding Universe. It is numerically shown that the ellipsoid becomes free from the expansion effects and starts to collapse when ρ/ρ_B attains the values of 5.4 to 5.6, depending on the configuration of the ellipsoid. The initial nonaxisymmetric structure is amplified in the course of the gravitational collapse and finally reaches an infinitely thin elliptical disk. When the angular momentum is large, the gravitationally bound system cannot be established within 10^{10} years. If the disk galaxy is formed from an initial density fluctuation with sufficient angular momentum, the initial velocities must be rather smaller than the general expanding velocity, otherwise the density fluctuation cannot rapidly become a gravitationally bound system in the plane perpendicular to the angular momentum vector. If this mechanism is correct, it would be indicative of the presence of primordial strong turbulence in the expanding Universe. (auth)

31889 NEWTONIAN HYDRODYNAMICS IN AN EXPANDING UNIVERSE IN TERMS OF THE SCALAR–TENSOR THEORY. Nariai, Hidekazu (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 1, 118–33(Jan 1972).

In view of a possible relevance of the scalar-tensor theory of gravitation to various cosmological and astrophysical problems, Newtonian hydrodynamics suitable at the matter dominant stage of the Brans–Dicke Universe is formulated and a formalism for dealing with various nonlinear effects of cosmic fluid being important during the formation of galaxies is developed in comparison with the previous one based on the general relativistic cosmology. In contrast with the situation in the linear theory of gravitational instability, it is shown in the case of a density perturbation with spherical symmetry that the critical epoch and density ratio for the occurrence of gravitational binding at the center may be considerably different from those in the Friedmann Universe. Dynamical equations for a rotating gaseous ellipsoid with uniform density are also derived and their general features are touched upon. (auth)

31890 PROBLEMS AND ACHIEVEMENTS OF NUCLEAR ASTROPHYSICS. PART I. NUCLIDIC ABUNDANCES AND COSMIC SYNTHESIS. Kuchowicz, Bronislaw (Univ., Warsaw). Postepy Fiz.; 22: No. 5, 495–509(1971). (In Polish).

A short survey of problems considered in nuclear astrophysics is given. The question of the abundance of chemical elements and their isotopes which forms the basis for studies on the origin of the elements is outlined. Various theories of cosmic nucleosynthesis are presented, and a historical outline of the development of nuclear astrophysics is given. (auth)

31891 NONHOMOLOGOUS EXPANSION IN COSMOLOGY. Chernin, A. D.; Moros, B. S.; Vandakurov, Yu. V. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett.; 39A: No. 3, 233–4 (8 May 1972).

A simple nonhomologous generalization of Friedmann's cosmological model is obtained and briefly discussed. (auth)

31892 NOSINGULAR UNIVERSE WITH TORSION. Kopczynski, W. (Univ., Warsaw). Phys. Lett.; 39A: No. 3, 219–20(8 May 1972).

The problem of a spherically symmetric gravitational field produced by spinning dust is solved in the framework of the Einstein–Cartan theory. There exists a two-parameter family of world models without singularities of the Friedmann type. (auth)

Planetary Phenomena

Refer also to abstracts 31199, 31870, and 31939.

31893 (UCRL–73846) CORRELATION OF THEORY AND EXPERIMENT FOR HIGH-PRESSURE HYDROGEN. Hoover, William G.; Ross, Marvin; Bender, C. F.; Rogers, Forrest; Olness, R. (California Univ., Livermore. Lawrence Livermore Lab.). [1972]. 14p. (CONF-720318–1). Dep. NTIS.

From High pressure physics and planetary interiors conference; Houston, TX. (1 Mar 1972).

Recent quantum calculations and high-pressure experiments both agree on the magnitude of the forces with which hydrogen molecules interact. The calculated forces have to be determined in two steps: the repulsion is determined by Hartree–Fock calculations, while the attraction is deduced semi-empirically. The "experimental" forces are inferred from recent data on hydrogen shock compressed to 214 kilobars. The agreement indicates the usefulness of a pair-potential description of dense hydrogen and suggests using potentials consistent with both theory and experiment that pressures of at least 1.7 megabars will be required to make metallic hydrogen. The expected lifetime of the metal at atmospheric pressure is very short. (auth)

31894 RUBIDIUM–STRONTIUM ISOTOPE CHARACTERISTICS OF LUNAR SOILS. Cliff, R. A.; Lee-Hu, C.; Wetherill, G. W. (Univ. of California, Los Angeles). J. Geophys. Res.; 77: No. 11, 2007–13(10 Apr 1972).

K, Rb, and Sr concentrations and Sr isotopic compositions are reported for hand-picked fractions from the 175- to 1000-μm Apollo 12 fines samples 12032 and 12070. In addition, two <1-mm bulk fines samples, 14163,160 and 14259,21, from Apollo 14 were analyzed; these have model Rb–Sr ages close to 4.6 b.y. The Apollo 14 data indicate the presence of a radiogenic component of 4.6-b.y. model age like the Apollo 12 fines, confirming a very early geochemical differentiation of the moon. Progressively greater enrichment in K and Rb relative to the bulk fines is shown by microbreccia from both samples, ropy brown glass from 12032, and light-grey lithic fragments from 12032. Model Rb–Sr ages, based on a basaltic achondrite initial ratio, are generally close to 4.6 b.y. The microbreccias and ropy brown glass have model ages that are younger but indistinguishable from 4.6 b.y. within analytical error. Light grey lithic fragments from 12032 have a model age of 5.1 b.y. and must have had a multistage Rb/Sr evolution. The data are broadly compatible with two-component mixing models of the Apollo 12 fines. On the basis of modal composition, the microbreccia is considered the major nonbasaltic constituent. A more complex model is necessary, since the light-grey lithic fragments, at least, have a distinct Rb/Sr isotopic history. There is no compelling evidence that all the exotic material was introduced in a single event. (auth)

31895 PLANETARY ATMOSPHERES. International Astronomical Union Symposium No. 40 Held in Marfa, Texas, October 26–31, 1969. Sagan, Carl; Owen, Tobias C.; Smith, Harlan J. (eds.). New York; Springer-Verlag New York Inc. (1971). 421p. $25.70. (CONF-691069).

A discussion of Venus in Part I puts emphasis on its atmosphere as probed by the Soviet Venera series and the degree to which the Russian probe results are consistent with the rapidly increasing information available from spectroscopy of the upper atmosphere and radio-astronomy observations of the lower atmosphere and surface characteristics. Models of the Venus atmosphere are now relatively consistent between the various modes of investigation; among the principal remaining puzzles are details of water-vapor detectability and abundance and the nature of the clouds, although considerable evidence was presented in favor of hydrated ferrous chloride as a principal cloud material. Martian characteristics discussed in Part II include: optical properties, CO_2 absorption, water-vapor absorption, Mariner observations, cloud motions and atmospheric dynamics, and the upper atmosphere. New insights are presented on the Martian large-scale circulation, total abundance of constituents, partial pressure of the atmosphere, and the predominantly CO_2 character of the polar caps. Exospheric properties of Mars are uncertain. Part III (Outer Planets) first presents papers on Jupiter's color variations, equatorial belt temperature during the 1965 apparition, and cloud structure near 8.5 μ. Papers are also devoted to: atmospheric depths of Jupiter, Saturn, and Uranus; spectral characteristics and structure of the cloud layer of Saturn; upper limit of hydrogen and helium on Titan; estimate of the H_2 abundance in the atmosphere of Uranus from the pressure-induced spectrum; and the spectrum of Uranus in the region 4800 to 7500 A. Part IV included the remarks made at the dedication of the 107-inch reflector, Oct. 30, 1969. (J.C.W.)

31896 DENSITY AND FLUX DISTRIBUTIONS OF NEUTRAL GASES IN THE LUNAR ATMOSPHERE. Yeh, T. T. J.; Chang, G. K. (Bellcomm, Inc., Washington, D. C.). J. Geophys. Res.; 77: No. 10, 1720–8(1 Apr 1972).

From kinetic theory of gases, numerical calculations were made of the density and flux distributions in the lunar atmosphere resulting from variations in the assumed surface gas temperature (T_0) and density (N_0). Computation of neon density distributions along a 100-km equatorial circular orbit shows that the density on the dayside is about 1 order of magnitude higher than that on the nightside for N_0 = constant, but is a factor of 2 smaller for $N_0 \sim T_0^{-5/2}$, as given by Hodges and Johnson (1968). Argon, on the other hand, will be more abundant on the dayside in both cases, by ~250 for constant $N_0 \sim T_0^{-5/2}$. In the 8 × 60 nm elliptic descent orbit of Apollo 15, the relative changes of density for the two values of N_0 are ~50 and ~25 for neon, and $\sim 3 \times 10^3$ and $\sim 7 \times 10^2$ for argon. This marked contrast between daytime and nighttime densities is not surprising: the fraction of fast gas molecules that can reach the above high-altitude orbits is most sensitive to temperature. Computation of flux distributions versus altitude over the equatorial terminator shows that a positive net flux from the hot side to the cold side persists at all altitudes if N_0 = constant; however, when $N_0 \sim T_0^{-5/2}$, the net flux is positive at higher altitudes but negative at lower altitudes with approximately zero net integrated flux (over altitude). Substantial lateral transport, in addition to the effects of particle loss ensuing from thermal escape, is also evident from the density distribution of hydrogen in a 100-km equatorial orbit, which was computed on the basis of the surface flux distribution given by Vogel (1966). (auth)

31897 MODEL FOR RADON DIFFUSION THROUGH THE LUNAR REGOLITH. Friesen, L. J.; Heymann, D. (Rice Univ., Houston, Tex.). Moon; 3: No. 4, 461-71(Mar 1972).

A model for radon diffusion through the lunar regolith is proposed in which the atom migrates by random walk. The regolith is represented by a system of randomly oriented baffles in which the mean distance d which the atom travels between two collisions takes on the role of a mean free path. The effective mean time between two collisions depends on two entities: the actual mean time-of-flight and the mean sticking time on grain surfaces for one collision. The latter depends strongly on the temperature and the heat of adsorption of radon on regolith materials. Both d (mean free path) as well as Q (heat of adsorption) are either poorly known or unknown for the lunar regolith; hence these quantities are treated as free parameters. Because of the greatly different mean lifetimes against radioactive decay of ^{219}Rn, ^{220}Rn, and ^{222}Rn, the regolith acts as a powerful "filter" for these species. ^{222}Rn escape is significant (32%) even for d = 1 μ, Q = 7.0 kcal/mole and a regolith depth of 4 m. Calculations of radon escape from a 4 m thick regolith, using d = 1, 10 and 80 μ and Q = 4.0, 5.2 and 7.0 kcal/mole show that the ^{222}Rn/^{220}Rn escape ratio can be as small as 7.7 and as large as, or larger than 47. The small value of 7.7 is of particular interest, because it is nearly equal to the escape ratio inferred by Turkevich et al. from their Surveyor 5 results. (auth)

31898 LONG-BASELINE ANALYSIS OF A JOVIAN DECAMETRIC L BURST. Lynch, M. A. (Univ. of Florida, Gainesville); Carr, T. D.; May, J.; (and others). Astrophys. Lett.; 10: No. 4, 153-8(Apr 1972).

Three-station interferometer observations of a 150-msec Jovian burst at 18 MHz yielded fringe visibilities of practically unity over baselines up to 462,000λ. An approximately constant phase relationship between the burst modulation envelope and the "carrier wave" beneath the envelope suggests that the envelope did not result from a sweeping beam or from solar-wind interference, but instead kept the same shape it had on leaving the planet. (auth)

31899 MEASUREMENTS OF LUNAR MAGNETIC FIELD INTERACTION WITH THE SOLAR WIND. Dyal, P. (Ames Research Center, Moffett Field, Calif.); Parkin, C. W.; Snyder, C. W.; Clay, D. R. Nature (London); 236: No. 5347, 381-5 (21 Apr 1972).

It is stated that the remanent magnetic field at the lunar surface is compressed as much as 40% above its initial value by the solar wind, but the total remanent magnetic pressure is less than the stagnation pressure by a factor of six, implying that a local shock is not formed. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

Refer also to abstracts 31709, 31866, and 31867.

31900 (AD–734530) ELECTROMAGNETIC ION-CYCLOTRON INSTABILITIES IN MULTICOMPONENT MAGNETOSPHERIC PLASMAS. Research Report, March–July 1971. Cornwall, John M.; Schulz, Michael (Aerospace Corp., El Segundo, Calif.). 1 Dec 1971. Contract F04701-71-C-0172. 23p. (SAMSO-TR-71-290). NTIS.

Growth rates for ion electromagnetic cyclotron (EMC) modes are calculated for several unconventional cases of magnetospheric importance, including total absence of cold plasma and presence of artificially injected heavy-ion plasma. Artificial injection of a very heavy ion such as barium or cesium is likely to suppress, rather than enhance, instability in the important ion-EMC mode, while injection of a light ion like lithium should be very effective in promoting instability in the ring current outside the plasmapause. (auth) (NTIS)

31901 (TRITA-EPP–71-14) POTENTIAL DOUBLE LAYERS IN THE IONOSPHERE. Block, Lars P. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). [nd]. 47p. Dep. NTIS (U. S. Sales Only).

Double layers (sheaths) are frequently observed in laboratory discharges but are largely overlooked in space physics. Recent observations have indicated the existence of sheaths in the upper ionosphere. A review of sheath theories in plasmas is given in terms of macroscopic equations for thermal plasmas. The role of Bohm criteria for the existence of sheaths is analyzed. The Langmuir condition is rederived and demonstrated for stationary and moving sheaths. Also treated are sheaths with reduced or vanishing current and particles trapped between sheaths and magnetic mirrors. Finally, consequences of sheaths in space for auroral-particle acceleration and auroral forms are discussed. In particular, it is shown that both stable and transient sheaths may be associated with simultaneous precipitation of ions and electrons. (auth) (Sweden)

31902 (TRITA-EPP–71-21) FEASIBILITY STUDY OF A MODEL EXPERIMENT FOR THE EQUATORIAL ELECTROJET. Buti, B.; Lindberg, L. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Sep 1971. 18p. Dep. NTIS (U. S. Sales Only).

The possibility of setting up a model experiment for the simulation of the equatorial electrojet in the laboratory was discussed. With the parameters given in the text, it seems feasible to simulate the electrojet. The model experiment would give the order of magnitude and the direction of the electric field existing in the ionosphere; this in turn would shed light on the validity of the dynamo theory. It could be determined whether the electron-density gradient or the gas-density gradient or both are responsible for the formation of the equatorial electrojet. (auth) (Sweden)

31903 RADIATING ATMOSPHERE. Proceedings of a Symposium Held at Kingston, Ontario, August 3–14, 1970. McCormac, B. M. (ed.). Astrophysics and Space Science Library. Volume 24. Dordrecht, Netherlands; D. Reidel Publishing Company (1971). 466p. (CONF-700851).

Thirty-seven papers are presented that deal with the following areas: (1) atmospheric airglow emissions, (2) atmospheric processes, (3) aurora, (4) auroral precipitation, (5) particle precipitation, (6) radio observations, and (7) auroral morphology. (M.O.W.)

31904 ARTIFICIAL HEATING OF THE LOWER IONOSPHERE. Showen, Robert L. (Rice Univ., Houston, Tex.). J. Geophys. Res.; 77: No. 10, 1923-33(1 Apr 1972).

The lower ionosphere was heated in a controlled experiment at the Arecibo Observatory. A 1-MW 40-mHz transmitter causes detectable heating from 80 to 120 km, and at 90 km the ambient electron temperature can be doubled. The 430-mHz radar backscatter system is used to measure the increase in electron temperature. Heating can be observed only in the daytime when the E region is present. Experiments with heating pulse lengths of 0.5 to 5 msec confirm predictions of the magnitude of heating if it is assumed that the heating is caused by collisions of the electrons with neutral molecules. Profiles of the deduced electron–neutral collision frequency are given. Thermal relaxation times are measured to determine the cooling parameter G, and the results agree with cross-modulation experiments at lower altitudes. (auth)

31905 ATMOSPHERIC DENSITY VARIATIONS AT 140 KILOMETERS DEDUCED FROM PRECISE SATELLITE RADAR TRACKING DATA. DeVries, Leonard L. (Marshall Space Flight Center, Huntsville, Ala.); Schusterman, Leonard; Bruce, Richard W. J. Geophys. Res.; 77: No. 10, 1905-13(1 Apr 1972).

The technique of evaluating density values from precise radar-tracking data of satellites in the altitude region 130 to 140 km is discussed. Inclinations of these satellites were between 106 and 112°. A detailed examination of all elements of the density-reduction techniques was conducted, and consideration was given to recent advances in geodesy, drag-coefficient modeling, and orbit-determination techniques. Ten days of high-resolution density data deduced from orbital decay of each of three satellites are presented. Three types of density variations at 140 km are discernible in these data: (a) periodic daily density variations with a density amplitude of about 10%; (b) density increases of up to 35% associated with enhanced geomagnetic activity during which the planetary geomagnetic index Kp reached a value of 8 units; and (c) an observed semiannual variation of about 20%, which indicates a total semiannual variation of 35 to 40%. These variations are discussed and compared with other results. (auth)

31906 DAYTIME AND NIGHTTIME ELECTRON TEMPERATURES FROM TOPSIDE RESONANCES. Feldstein, R.; Graff, P. (Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux, France). J. Geophys. Res.; 77: No. 10, 1896-1904 (1 Apr 1972).

The beat pattern apparent on topside plasma and upper hybrid resonances is analyzed on 22 Alouette-2 ionograms distributed in one daytime and one nighttime series. The experimental beat frequencies oscillate around a monotonic variation that agrees with the result of a WKB treatment of the oblique-echo model. The frequency of these oscillations differs from the proton gyrofrequency. Comparing the experimental monotonic component of the variation with theory provides reasonable values of the electron temperature for nighttime as well as for daytime conditions. (auth)

31907 NEUTRAL-PARTICLE WAKE METHOD FOR MEASURING THE ATMOSPHERIC TEMPERATURE FROM A SATELLITE. Brace, L. H.; Hoegy, W. R.; Theis, R. F.; Wharton, L. E. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 77: No. 10, 1885-95(1 Apr 1972).

A method is described that would permit a satellite-borne neutral mass spectrometer to measure the atmospheric temperature. The spectrometer examines the partial pressure variations that occur at the wake of a small rectangular baffle swept across the entrance orifice of the spectrometer. For a given baffle size and for a mounting distance from the orifice, the depth of the resulting pressure minimum depends only on the thermal velocity or temperature of the observed species. The validity of the method can be checked by measuring the wake characteristics of more than one species and/or by employing each of several baffle sizes. The theory includes the effect of a finite orifice size, finite baffle length, and the backscattering of particles from the baffle into the orifice. It is found that a suitable baffle arrangement can be achieved that will permit the temperature to be measured over at least the range normally encountered in the thermosphere (200 to 2000°K) and, depending on the sensitivity and background pressure of the spectrometer, over an altitude range of about 140 to 600 km. (auth)

31908 NEUTRAL DENSITY MEASUREMENTS NEAR 400 KILOMETERS BY A MICROPHONE DENSITY GAGE ON OGO 6 DURING JULY 12–15, 1969. Anderson, A. D.; Sharp, G. W. (Lockheed Palo Alto Research Lab., Calif.). J. Geophys. Res.; 77: No. 10, 1878-84(1 Apr 1972).

An analysis is presented of persistent density peaks (maximums) measured near 400 km during daytime (1425 LT) by the Lockheed microphone density gage on Ogo 6 during July 12–15, 1969. Most of the density peaks occurred between geomagnetic latitudes 50 and 61°N and L values 2.3 and 4.7. The average density change in the peaks was 27%. Most of the peaks appeared in the longitude sector from 150 to 350°E. No density peaks were measured in the 50 to 130°E sector during the 3½-day observation period. A persistent pair of density peaks was present on seven successive orbits during July 13 and July 14 (both geomagnetically disturbed days) near geomagnetic latitudes 53 and 61°N, respectively. (auth)

31909 TWILIGHT AND NIGHTTIME IONOSPHERIC TEMPERATURES FROM OXYGEN λ6300 AND λ5577 SPECTRAL-LINE PROFILES. Feibelman, W. A.; Hake, R. D. Jr.; Sipler,

D. P.; Biondi, M. A. (Univ. of Pittsburgh). J. Geophys. Res.; 77: No. 10, 1869-77(1 Apr 1972).

Fabry–Perot interferometer measurements of atomic-oxygen λ6300- and λ5577-line profiles from twilight and nightglow are used to determine the neutral temperatures in the F2 and E regions of the Earth's ionosphere. The exospheric temperatures $T_n(\infty)$ determined from the λ6300 profiles are usually somewhat higher than the temperatures calculated from Jacchia's model, and differences as large as ~ 300°K are noted when $T_n(\infty)$ equals 1500 to 1600°K. The postsunset and predawn rate of change of $T_n(\infty)$ is often substantially larger than the Jacchia prediction. The λ5577 (E region) measured temperatures range from 200 to 220°K on quiet nights to 500 to 600°K during geomagnetic storms. (auth)

31910 FIELD-LINE CONNECTION BETWEEN SCINTILLATION AND IONOSPHERIC CONDITIONS CAUSING SPREAD E. Chen, A. A.; Chin, P. N.; Chance, M. P. (Univ. of the West Indies, Mona, Jamaica). J. Geophys. Res.; 77: No. 10, 1859-68(1 Apr 1972).

Analysis of amplitude records of transmissions from satellites indicates that F-region irregularities causing scintillation and ionospheric conditions causing spread E are connected by the magnetic-field lines. The connection between spread E and scintillation can be explained by the E × B instability mechanism proposed by G. C. Reid (1968). Other evidence presented to support this hypothesis includes (1) the negative (positive) correlation between scintillation activity and magnetic activity south (north) of Jamaica, which is located in the vicinity of the Sq focus, and (2) the presence of spread E at the foot of ionization troughs caused by neutral winds. (auth)

31911 RELATIVE MOTION OF AURORAL CONJUGATE POINTS DURING SUBSTORMS. Stenbaek-Nielsen, H. C. (Univ. of Alaska, College); Davis, T. N.; Glass, N. W. J. Geophys. Res.; 77: No. 10, 1844-58(1 Apr 1972).

Aircraft observations of the conjugacy of visual auroras during a disturbed period in late March 1968 show the existence of two auroral systems. An equatorward arc system, composed of weak multiple arcs (and, in evening, the hydrogen arc), lying near invariant latitude 63 to 65°, shows a high degree of conjugacy with little or no displacement of conjugate auroras relative to the GSFC 12/66 model of the geomagnetic field. Separated from this system is a poleward arc system where conjugate auroras occur but where similar auroras are displaced by up to 300 km. Before the auroral breakup, the southern hemisphere auroras are displaced westward of their northern counterparts. At the time of the breakup, the sense of the longitudinal displacement reverses so that, thereafter, the southern auroras occur eastward of their northern conjugates. An equatorward displacement of the southern hemisphere poleward arc system occurs during high magnetic activity. (auth)

31912 AURORAL INFRASONIC WAVE-GENERATION MECHANISM. Wilson, Charles R. (Univ. of Alaska, College). J. Geophys. Res.; 77: No. 10, 1820-43(1 Apr 1972).

The morphology of auroral infrasonic-wave (AIW) substorms, as determined from infrasonic observations at Inuvik (68.4°N), College (64.9°N), and Palmer (60.8°N) along a magnetic meridian through Alaska, shows that AIW are never observed propagating in a poleward direction, even though auroral activity frequently occurred south of the stations. AIW have been shown to be infrasonic bow waves generated by supersonic westward, equatorward, or eastward motions of auroral-electrojet arcs. All AIW are observed from azimuths that vary from parallel to the auroral oval to transverse to the oval in an equatorward direction depending on the local magnetic time. Specific examples of auroral poleward expansions that cross the Inuvik zenith have been studied. It was found that even highly supersonic poleward motions of arcs with strong electrojets do not produce infrasonic bow wages. When a reversal in direction of the poleward expansion occurs and the arcs subsequently move equatorward, strong AIW are observed from the arcs. This asymmetry in the occurrence of AIW with respect to direction of motion of an arc is interpreted as an intrinsic asymmetry in the generation mechanism within the auroral arcs and not as a propagation effect. It is postulated that the basic acoustic pulse within the electrojet arcs is caused by collisions with the neutral gas of positive ions that are driven by electrodynamic drift in the E region of the auroral arc. Thus Lorentz force is the coupling mechanism between the electrojet-current carriers and the neutral gas. An ionization–collision process occurs within the auroral arcs for those arcs that are moving supersonically in a direction parallel to the direction of the neutral ionization drift. The resulting increase in ion density for such arcs reduces the time constant for ion drag, and thus the Lorentz-force coupling is effective in producing an infrasonic shock wave. If the supersonic translation of the primary auroral electron sheet has a component of motion parallel to the electrodynamic drift of the positive ions, an auroral infrasonic shock wave will be produced in the E-region ionosphere and propagate to the ground as a modified shock or bow wave. If, on the other hand, the auroral-arc motion is antiparallel to the drift of the positive ions, no AIW will be produced. (38 references) (auth)

31913 AURORAL SPECTRUM BETWEEN 1200 AND 4000 ANGSTROMS. Sharp, William E. (Univ. of Michigan, Ann Arbor); Rees, Manfred H. J. Geophys. Res.; 77: No. 10, 1810-19 (1 Apr 1972).

Spectroscopic observations of an auroral event were made simultaneously by airborne and satellite-borne scanning spectrometers, in the wavelength region between 1200 and 4000 A. Photon emission rates of several vibrational bands of the N_2, 2nd positive, Vegard–Kaplan, and Lyman–Birge–Hopfield systems, the N I lines at 1200 A and 3466 A, and O I lines at 1304 A, 1356 A, and 2972 A were recorded. Model calculations of the emission rates of the observed features are found to be in reasonable agreement with the measurements. Electron impact excites the nitrogen band systems, as well as the OI 1356-A line. A spectral feature at 2150 A is tentatively identified as the (1,0) gamma band of NO. (auth)

31914 OBSERVATIONS OF SAR ARCS FROM OV1-10. LaValle, S. R.; Elliott, D. D. (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res.; 77: No. 10, 1802-9(1 Apr 1972).

Three midlatitude red arcs were measured by the night airglow photometer on board OV1-10 (1966-111B) during the winter of 1966–1967. One arc was observed as a conjugate phenomenon. Another arc was observed for 2 days at a constant local time and was found to decrease in intensity, increase in width, and move to higher L values with universal time. Both arcs were found to be associated with the plasmapause, the location of which was determined from the vlf measurements made by OV3-3 (1966-70A). These observations are shown to be consistent with the theory that SAR arcs are generated at the plasmapause as a consequence of the turbulent dissipation of ring current energy. (23 references) (auth)

31915 PROPAGATION OF Pc 1 HYDROMAGNETIC WAVES ACROSS NORTH AMERICA. Campbell, W. H.; Thornberry, T. C. (National Oceanic and Atmospheric Administration, Boulder, Colo.). J. Geophys. Res.; 77: No. 10, 1941-50(1 Apr 1972).

The apparent horizontal group velocity of hydromagnetic (hm) waves of natural origin near 1 Hz was found to be about 2.3×10^3 km/sec from simultaneous measurements made in Hawaii, Alaska, Washington, Colorado, and Quebec. The signal seemed to move essentially westward into the dark hemisphere from the dawn terminator and showed a dispersion of about a 0.5-sec recurrence period per hertz emission frequency per degree longitude. Problems of computations of magnetospheric properties from the hm-wave characteristics are discussed. (36 references) (auth)

31916 MAPPING OF THE ELECTRIC FIELD OF THE Sq CURRENT INTO THE LOWER ATMOSPHERE. Volland, H. (Univ., Bonn). J. Geophys. Res.; 77: No. 10, 1961-5(1 Apr 1972).

The electric field of the geomagnetic Sq current is mapped into the lower atmosphere. Equipotential surfaces of this potential field are calculated depending on altitude, latitude, and local time. It is shown that at balloon altitudes the horizontal components of this field have magnitudes about $\frac{1}{10}$ of the thunderstorm-generated main geoelectric field. At the ground, the Sq field is about 5% of the main field. (auth)

31917 COMMENT ON LETTER BY W. SWIDER, SOURCES FOR $H^+(H_2O)_n$ IONS IN THE D REGION. Burke, Rudolf R. (AeroChem Research Labs., Inc., Princeton, N: J.). J. Geophys. Res.; 77: No. 10, 1998-2003(1 Apr 1972).

The difficulties concerning the formation of $H^+(H_2O)_n$ ions in the D region were discussed by Swider (NSA 25: 7280) and the source for these ions was proposed as methane. It is pointed out that a chemionization reaction was omitted. The possible importance of metal atoms in the ion production process is discussed also. If methane participates in the ion chemistry of the D region, it will most likely be via chemionization reaction $CH + O \rightarrow CHO^+ + e$ followed by the rapid proton-transfer reaction $CHO^+ + H_2O \rightarrow CO + H_3O^+$. A discussion to verify these reactions is made. Excited metal atoms M may also contribute to the ion production process via chemionization reactions: $M^* + O \rightarrow MO^+ + e$. If the CH concentration in the upper D region is $\geq 10^2$ ml^{-1} or if M^* concentrations are ≥ 10 ml^{-1}, it is concluded that the chemionization reactions be considered in the structure of this region. In a reply, Swider states the reaction was not introduced because (a) the D region is thought to behave in a manner indicative of photoionization control, and (b) the reaction has generally been believed to be endothermic, the chemionization reaction being important in flame chemistry where there are high temperatures. (J.C.W.)

31918 DISCUSSION OF PAPER BY G. ATKINSON, AURORAL ARCS: RESULT OF THE INTERACTION OF A DYNAMIC MAGNETOSPHERE WITH THE IONOSPHERE. Sato, Tetsuya; Ogawa, Tadahiko (Kyoto Univ.). J. Geophys. Res.; 77: No. 10, 1994-7 (1 Apr 1972).

An attractive model of auroral-arc formation was developed by Atkinson (J. Geophys. Res., 75: 4746(1970)). The mechanism involving the interaction of a dynamic magnetosphere with the ionosphere is discussed. Atkinson assumed a constant value for field-aligned currents of cold electrons (or auroral protons) in the process, and took into account only the steady state under the assumption of constant value for the currents. The solution deduced in the paper has no arc-like solution, but the usual result. This implies that any perturbation of the order of 40 km will not grow so markedly that the keV electrons will play a part in arc formation. To have Atkinson's solution, it is believed that an additional mechanism that produces an initial conductivity variation sufficient to control the field-aligned currents of cold electrons must be considered. In a reply, Atkinson states that Sato and Ogawa object to the auroral-arcs model principally on the grounds that the field-aligned currents of auroral electrons due to precipitating electrons act as the driving force and that the return current, which consists of an upward flow of cold electrons, adjusts to this force. The results of Atkinson (1970) apply when the dielectric property of the plasma is included. Atkinson believes that the basic difference of the two models arises from the poorly understood physics of field-aligned currents. (J.C.W.)

31919 SEMIANNUAL CHANGE IN EXOSPHERIC TEMPERATURE. Titheridge, J. E. (Univ. of Auckland, New Zealand). J. Geophys. Res.; 77: No. 10, 1978-81(1 Apr 1972).

Results of the density and temperature of the neutral atmosphere above 100 km are reviewed and show three major variations: a diurnal change with a global maximum temperature about 30% greater than the nighttime minimum temperature T_0; a solar-cycle change, which is given in terms of the 10.7-cm solar flux F by the 1965 Jacchia relation $T_0 = 3.60F + 418°K$ and a semiannual variation through about 20% having minimums in January and July. In 1969, Jacchia et al. showed that the semiannual oscillation was very stable. Assuming that the semiannual oscillation was caused by changes in temperature, it was found that essentially the same changes occurred at all heights from 250 to 650 km. Observations have shown that changes occur at 150 to 200 km and also at great heights. The Jacchia model was a simple temperature-varying model and was not now applicable. To solve these difficulties, Jacchia (1971) suggests that the semiannual density variation can be adequately represented by a pure density-varying model in which the amplitude of the variation is a function of height. All published data on experiments are examined and the correctness of Jacchia's reappraisal is discussed. No clear-cut answer is yet known for the density variation. (J.C.W.)

31920 END EFFECT IN LANGMUIR PROBE RESPONSE UNDER IONOSPHERIC SATELLITE CONDITIONS. Sanmartin, Juan R. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids; 15: No. 6, 1134-43(Jun 1972).

A theory is presented for an end effect in the current response of a highly negative cylindrical Langmuir probe in a collisionless plasma flow. Under conditions where the ratio of probe radius to Debye length is small and the ion-acoustic Mach number is large, the current exhibits a strong peak when the probe axis is brought into alignment with the flow direction. Closed formulas are given for the maximum and angular half-width of the peak, and universal graphical results are presented for the entire peak structure. The theory shows very good agreement with experimental data. The use of the end effect for diagnostic purposes, in particular, for the determination of the ion temperature, is discussed. (auth)

31921 IONOSPHERIC EFFECTS OF SOLAR FLARES. VI. CHANGES IN D-REGION ION CHEMISTRY DURING SOLAR FLARES. Mitra, A. P. (National Physical Lab., New Delhi); Rowe, J. N. J. Atmos. Terrest. Phys.; 34: No. 5, 795-806 (May 1972).

Evidence has been presented by Rowe et al. (1970) showing a drastic decrease of the effective recombination coefficient during solar flares. In this paper, the nature and magnitude of the decrease is examined as a function of flare flux, model recombination coefficient profiles are developed for different flare conditions, and a theory of how these decreases can occur is offered. A new ion chemical scheme consisting of a six-ion (four positive and two negative) model is presented. It is shown that this decrease is due to different relative increases in the electron density and the negative ion density, or to a change in the dominant positive ion from a complex hydrated ion with a large recombination coefficient to a simple ion with a smaller recombination coefficient. At 70 km the former effect seems to be operating, while at 80 km the latter effect operates. (auth)

31922 EFFECT OF THE RING CURRENT AND POLAR ELECTROJET ON THE OVAL OF PROTON AURORAE. Evlashin, L. S. (Polar Geophysical Inst., Murmansk, USSR); Truttse, Yu. L.; Feldshtein, Ya. I. J. Atmos. Terrest. Phys.; 34: No. 5, 859-66 (May 1972).

The equatorial boundary of proton aurorae during magnetic disturbances is estimated by observing the occurrence and intensity of the H_α line. It is related to the intensity of the ring current (DR) as measured by the magnetic index D_{st} and to the intensity of the electrojet (DP) as measured by the strength of the disturbance in the midnight sector. During the night the boundary of the aurora is found to shift towards the equator by an amount that is related to the magnitude of D_{st}. At all times of day the shift towards the equator is closely related to the magnitude (DP) of the polar magnetic disturbance. (auth)

31923 ION-ACOUSTIC WAVES AND ASPECT SENSITIVITY IN RADIO AURORA. Hofstee, J.; Forsyth, P. A. (Univ. of Western Ontario, London). J. Atmos. Terrest. Phys.; 34: No. 5, 893-902(May 1972).

An earlier experiment established at least the occasional existence of ion—acoustic waves in the auroral plasma. As would be expected from theoretical considerations, the waves were found to be propagating in a plane perpendicular to the undisturbed local magnetic field. The present experiment reveals the presence of such waves propagating in directions that diverge significantly (approx 6°) from the preferred plane. It is suggested that the existence of a large horizontal sheet current could account for the observations by distorting the magnetic field more or less uniformly over a large volume of the ionosphere. (auth)

31924 DISTORTION OF THE E-REGION BY THE Sq CURRENT SYSTEM. Butcher, E. C. (La Trobe Univ., Bundoora, Australia). J. Atmos. Terrest. Phys.; 34: No. 5, 903-9(May 1972).

The amount of distortion of the E-region electron density at the magnetic equator caused by the Sq current system was computed using measured electron density and current density profiles. It is found that the distortion is quite significant and is dependent on the $\alpha(z)$ profile taken. The results obtained are used to explain other measurements on the E region affected by Sq. (auth)

31925 QUASIPERIODIC SCINTILLATION IN THE IONOSPHERE. Slack, F. F. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Atmos. Terrest. Phys.; 34: No. 5, 927-39 (May 1972).

The hypothesis is advanced that a regular cyclic type of fading seen occasionally on chart recordings of hf and vhf rf signals that have penetrated the ionosphere is a special case of the more normal irregular ionospheric scintillation. Analysis of satellite signals containing this special type of anomaly leads to a better understanding of ionospheric scintillation in general. It is shown how properties of normal scintillation are consistent with the two-ray interference formula derived for the more orderly pattern. As an illustration the analysis of an ionospheric irregularity appearing over Thule that provides height and electron-density measurement is included. Emphasis is given to the part reflection plays in scintillation, a process generally considered non-existent in hf and vhf propagation. (auth)

31926 RELATIONS BETWEEN THE DIRECTION OF THE IONOSPHERIC WIND AND THE SPORADIC Es LAYER. Harnischmacher, Ewald (Ionosphaeren-Institut, Breisach, Ger.); Rawer, Karl. Compt. Rend., Ser. B; 274: No. 4, 298-300 (24 Jan 1972). (In French).

The relations between two parameters characterizing the sporadic-E layer and the direction of the ionospheric wind are indicated for temperate latitudes in the summer: f_0E_s characterizes the maximum ionization and is largest when the wind is zonal (towards the east or west). In contrast, the height, $h'E_s$ is large for a wind blowing towards the pole, but small for a wind blowing towards the equator. Tide phenomena are in agreement with this hypothesis: 12- and 6-hour solar, or 6-hour lunar for f_0E_s, but 24- and 12-hour solar, or 12-hour lunar for $h'E_s$. (France)

31927 NEW INTERPRETATION OF THE SEASONAL VARIATIONS OBSERVED IN THE VERY LOW FREQUENCY MAGNETOSPHERIC WIND IN THE AURORAL ZONE. Houri, Andre (Univ., Paris). Compt. Rend., Ser. B; 274: No. 4, 301-4 (24 Jan 1972). (In French).

The wide-band vlf observations made of the magnetospheric wind are compared with previous observations made over a narrow band. The seasonal effect is confirmed and a new interpretation is suggested. (France)

31928 THEORY OF DISCRETE RADIO AURORA. Knox, F. B. (Dept. of Scientific and Industrial Research, Lower Hutt, N. Z.). J. Atmos. Terrest. Phys.; 34: No. 5, 747-64(May 1972).

Electric fields and ionization density gradients in the edges of optical auroral forms are such that the drift-gradient (cross-field) instability may easily occur, and give rise to radio aurora observable at metre wavelengths. The predictions of theory are compared with observations of type B_2 and B_3 (short and long discrete) radio aurora, and show good quantitative agreement in order of magnitude. Many apparently conflicting observations on the relation between radio and optical aurora are explicable by the theory. (auth)

31929 ELECTRIC SPACE CHARGE IN THE ATMOSPHERE. Muir, M. S. (Univ. of Natal, Durban, S. Afr.). J. Atmos. Terrest. Phys.; 34: No. 5, 941-6(May 1972).

Results are given of a method of using conventional field mills to measure electric space charge density in the atmosphere. The limit of accuracy of the method is 20 pC m^{-3}. Results due to the melting of snow and the presence of artificial sources of space charge are discussed. Concentrations of space charge density may persist in spite of apparently good conditions of atmospheric mixing, and the resultant effect on field mill calibration is shown to be important. (auth)

31930 NUMERICAL CALCULATION OF GRAVITY WAVE PROPAGATION IN A REALISTIC THERMOSPHERE. Klostermeyer, J. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). J. Atmos. Terrest. Phys.; 34: No. 5, 765-74(May 1972).

A full-wave calculation of gravity-wave propagation in a realistic thermospheric model, including the effects of height-dependent temperature and winds, of Coriolis force, viscosity, thermal conduction, and ion drag is described. In order to integrate the hydrodynamic equations, the height-dependent coefficients are approximated by piecewise constant ones, taking into account also terms that involve vertical derivatives. Numerically calculated results are compared with observational data deduced from ionograms. (auth)

31931 ELECTRON–ION AND ION–ION REACTION RATE COEFFICIENTS AT LOW ALTITUDES DURING A PCA EVENT. Larsen, T. R. (Norwegian Defence Research Establishment, Kjeller); Jespersen, M.; Murdin, J.; (and others). J. Atmos. Terrest. Phys.; 34: No. 5, 787-94(May 1972).

Based on experimental data from several ESRO PCA rocket flights, some considerations are presented regarding the mean values of the electron–ion dissociative recombination coefficient (α_d) and the ion–ion neutralization coefficient (α_i). The estimates yield values for $\alpha_d = 10^{-5}$ cm^3 sec^{-1} for heights between 60 and 67 km. The data indicate that α_i is smaller than α_d by a factor of 100. (auth)

31932 BALLOON STUDIES OF NEUTRONS (1 TO 10 MeV) AND γ RAYS (0.7 TO 4.5 MeV) AT EQUATORIAL LATITUDE. Albernhe, F.; Martin, I. M.; Talon, R.; Vedrenne, G. (Univ., Toulouse). Ann. Geophys.; 27: No. 3, 339-43(Jul 1971). (In French).

The results of a balloon experiment at an equatorial latitude of 10°N in Guiana are given. Variations in the flux and the spectra of 1- to 10-MeV neutrons and 0.7- to 4.5-MeV γ rays are analyzed as a function of altitude. The form of the spectra remains constant in a zone between 200 mb and 4 mb for both the neutrons and the γ rays. Furthermore, when these results are compared with those obtained by the ESR-18 satellite, a large part of the γ-ray flux detected at low altitudes is seen to be of extraterrestrial origin. This method appears to be useful for the observation of galactic γ rays in this energy range. (France)

31933 LATITUDINAL EVOLUTION OF THE ELECTRON CONTENT OF THE IONOSPHERE. Amayenc, P.; Bertin, F.; Papet Lepine, J. (Univ., Paris). Ann. Geophys.; 27: No. 3, 345-57(Jul 1971). (In French).

Diurnal and latitudinal variations in the electron content of the ionosphere were studied using the differential Faraday effect. Results obtained in the 40 to 70°N latitude range between winter 1964–1965 and winter 1966–1967 are described. It is shown that the elevation of the Sun has a particularly strong influence on the electron content in winter and spring. Geophysical mechanisms that might explain the latitudinal anomalies observed are discussed. (France)

31934 SYNOPTIC STUDY OF THE DISTURBED IONOSPHERE DURING IGY–IGC. 2. THE AMERICAN ZONE. Rajaram, G.; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Ann. Geophys.; 27: No. 3, 359-67(Jul 1971).

A detailed investigation of the $D_{st}(f_0F2)$ and $S_D(f_0F2)$ behavior observed from stations in the American zone ranging from 89°N dip to 75°S dip established the existence of certain anomalies in the known behavior of disturbance effects. The study of seasonal effects demonstrated the existence of an enhancement of the D/Q (f_0F2) ratio in winter midlatitudes, which is more marked at night than during the day, this ratio being larger than the corresponding ratio at the magnetic equator. The peak is larger in the southern American zone and seems to be associated with the geomagnetic anomaly observed in this region. (France)

31935 STUDY OF HETEROGENEITIES IN ELECTRON DENSITY BY DIFFERENTIAL FARADAY EFFECT MEASUREMENTS FROM ARTIFICIAL SATELLITES. Hanbaba, R. (Univ., Paris). Ann. Geophys.; 27: No. 3, 369-80(Jul 1971). (In French).

Faraday-effect measurements effected on signals emitted by the satellite Explorer 22 between January 1, 1965 and December 31, 1967 demonstrated the existence of 274 isolated electron-density irregularities. Only 19% of the irregularities are localized north of the station (48°49′ N, 2° E). Comparisons are made between the diurnal and seasonal variations in these irregularities and their parameters (maximum frequency of appearance occurs after sunrise in the winter). The evolution between one year and the next is less evident. Correlations with geomagnetic activity are observed but they are not very strong. (France)

31936 F REGION DRIFTS AND IRREGULARITIES OVER IBADAN. Bamgboye, D. K. Ann. Geophys.; 27: No. 3, 381-9 (Jul 1971).

Results of measurements on the drift and pattern parameters of F-region irregularities made at Ibadan during 1966–67, a period between the last sunspot minimum and the present sunspot maximum, are presented. A comparison of these results with those obtained previously at the same station suggests that in the F region the observed amplitude of the east–west velocity depends on the epoch of the solar cycle during which the observation is made. The present results also show that while the east–west velocity undergoes a seasonal variation with an annual phase, the elongation of irregularities has a semi-annual variation somewhat similar to the variation of the cosine of the solar-zenith angle. (France)

31937 METHOD FOR CALCULATING THE EVOLUTION OF THE ALTITUDE OF EMISSION OF THE FORBIDDEN LAMBDA = 6300 A LINE OF ATOMIC OXYGEN DURING THE PREDAWN ENHANCEMENT. Duboin, M. L. (Univ., Paris. CNRS, Paris). Ann. Geophys.; 27: No. 3, 391-9(Jul 1971). (In French).

A method for calculating the variations in the altitude and intensity of the 6300 A OI airglow line from data obtained using a rotating photometer, is proposed. The method is based on the hypothesis of a correlation between the solar depression in the conjugate magnetic region and red emission during predawn enhancement. These variations are compared with those that would be obtained if the excitation mechanism were due to radiative recombination. This hypothesis is not confirmed by preliminary data obtained by the Observatoire de Haute-Provence. (France)

31938 PHOTOELECTRON IMPACT EXCITATION TO $E^3\,\Sigma_g^+$ ELECTRONIC STATE OF MOLECULAR NITROGEN AND THE CASCADE CONTRIBUTIONS TO LOW LYING STATES IN DAY GLOW. Sharma, V. N.; Singh, R.; Tolpadi, S. K. (Banaras Hindu Univ., India). Ann. Geophys.; 27: No. 3, 419-22(Jul 1971).

The volume emission rates of the Herman–Kaplan system at altitudes greater than 120 km are calculated from the excitation functions of molecular nitrogen at the $E^3\,\Sigma_g^+$ electronic level and the midday atmospheric densities obtained from the 2, 5, and 8 models of the 1965 CIRA tables, corresponding to low, medium, and high solar activities. The intensity height profiles are also calculated and intercomparisons are made. A detailed discussion on the possibility of significant contributions to the population arising from the cascade of weakly excited states is given, emission from the first-positive system of molecular nitrogen in the electron aurora and dayglow being concerned. (France)

Particle Kinetics and Trapping

31939 LUNAR VARIATIONS IN THE PERUVIAN ELECTROJET. Tarpley, J. D.; Balsley, B. B. (National Oceanic and Atmospheric Administration, Boulder, Calif.). J. Geophys. Res.; 77: No. 10, 1951-60(1 Apr 1972).

The lunar variation in the Peruvian electrojet is investigated using E-region electron-drift measurements at Jicamarca and the H component of geomagnetic field data from Huancayo. The H-component records are divided into six bimonthly intervals and are analyzed for lunar variations by the Chapman–Miller method. L(H) shows a striking seasonal change with a range that varies from 50 γ in January and February to 7 γ in July and August. Lunar variations in the electron-drift data are obtained by forming average daily variation curves and subtracting the average curve from the measured curve on each day. The resulting residual drift velocities are arranged in lunar time and are averaged. The lunar electric field inferred from the drift data is of the order of 0.1 mV/m and shows seasonal variations that are similar to those in L(H), although the decline in amplitude from summer to winter is more abrupt in the electric field. The daytime lunar electric field is larger by at least 50% than the nighttime field. In the summer at Jicamarca, there is a 3-hour day–night phase shift in the field. (auth)

31940 OGO 5 OBSERVATIONS OF LHR NOISE, EMISSIONS, AND WHISTLERS NEAR THE PLASMAPAUSE AT SEVERAL EARTH RADII DURING A LARGE MAGNETIC STORM. Scarf, F. L. (TRW Systems Group, Redondo Beach, Calif.); Fredricks, R. W.; Smith, E. J.; Frandsen, A. M. A.; Serbu, G. P. J. Geophys. Res.; 77: No. 10, 1776-93(1 Apr 1972).

On May 15, 1969, Ogo 5 crossed the plasmapause during a major storm that produced severe geomagnetic disturbances (Kp up to 8–), large and rapid variations in ring-current intensity (as measured by Dst), intense low-latitude aurora, and persistent SAR arcs. Near the highly structured plasmasphere boundary, the electric- and magnetic-field sensors on Ogo 5 detected lower-hybrid-resonance noise bursts, whistlers, elf hiss, and other discrete signals or emissions. Some LHR noise bursts were associated with whistlers, and these high altitude phenomena resembled the corresponding ionospheric ones. A description of the vlf observations is given. It is shown that intense ulf magnetic signals were present near the plasmapause, and an attempt was made to relate these observations to the predictions of various theories of proton ring-current decay and SAR-arc formation. (35 references) (auth)

31941 STRONG PITCH-ANGLE SCATTERING OF ENERGETIC ELECTRONS IN THE PRESENCE OF ELECTROSTATIC WAVES ABOVE THE IONOSPHERIC TROUGH REGION. Koons, H. C.; Vampola, A. L.; McPherson, D. A. (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res.; 77: No. 10, 1771-5(1 Apr 1972).

Simultaneous measurements of energetic electrons and electrostatic waves in the midlatitude trough region indicate that events characterized by strong pitch-angle diffusion in the altitude range 2000 to 4500 km occur in the presence of elf electrostatic waves attributed to a current-driven ion cyclotron instability. Scattering by the electrostatic waves is sufficient to account for the strong pitch-angle scattering commonly observed by low-altitude satellites. The resulting precipitation creates a sharply defined, high-latitude boundary for energetic electrons as observed by low-altitude satellites. This boundary is similar to the feature generally referred to as the high-latitude trapping boundary. However, the precipitation boundary occasionally occurs on closed field lines at a significantly lower latitude than the trapping boundary. When present, the precipitation boundary is most sharply defined in the nighttime hemisphere. (auth)

31942 RADIAL DIFFUSION OF IONIZED HELIUM AND PROTONS: A PROBE FOR MAGNETOSPHERIC DYNAMICS. Cornwall, John M. (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res.; 77: No. 10, 1756-70(1 Apr 1972).

The comparison of radial diffusion of magnetospheric helium ions and protons is a sensitive test of the diffusion process assumed (magnetic or electrostatic fluctuations) and thus valuable as a probe of magnetospheric dynamics for protons, electrons, and heavy ions, as well as for the helium ions themselves. Radial profiles of ionized helium flux and protons are calculated, and certain physical effects ignored in previous treatments are taken into account. These effects include (a) charge-exchange processes ($He^{++} \rightarrow He^{+} \rightarrow He$ or He^{++}), which provide a loss mechanism as well as a way of converting solar-wind alpha particles to He^{+}, and (b) contribution of fluctuating electrostatic fields to the radial-diffusion coefficient. Like nearly all other treatments of radial diffusion, other processes such as pitch-angle scattering have been omitted for lack of quantitative knowledge. The combination of a solar-wind source, of losses dominated by charge exchange, and of electrostatic radial diffusion (with a plausible power spectrum for the fluctuations) leads to (a) fast conversion of alphas to He^{+}, and (b) a radial-diffusion coefficient proportional, at fixed energy per nucleon, to $(Z/A)^2$. Thus helium and other heavier ions (C, N, O) diffuse much more slowly than protons in the magnetosphere, and this slow diffusion can explain the very small α/p ratios observed near $L = 3$. (44 references) (auth)

31943 AVERAGE PLASMA-SHEET CONFIGURATION NEAR 60 EARTH RADII. Meng, C.-I. (Univ. of California, Berkeley); Mihalov, J. D. J. Geophys. Res.; 77: No. 10, 1739-55(1 Apr 1972).

Nearly three years of Ames magnetometer data from Explorer 35 are used to establish plasma-sheet configurations in the geomagnetic tail at the lunar orbit. The plasma sheet is defined either as a region with different field orientations from normal magnetic-field directions in the tail, or as a region where the magnetic field variance is greater than elsewhere in the tail. The plasma-sheet configuration at the lunar orbit derived in this manner is found to be similar to the distribution at 18 R_E observed by Vela satellites. The seasonal dependence and variations with geomagnetic activity are also presented. (41 references) (auth)

31944 OBSERVATION OF NONUNIFORM STRUCTURE OF THE EARTH'S BOW SHOCK CORRELATED WITH INTERPLANETARY FIELD ORIENTATION. Greenstadt, E. W. (TRW Systems Group, Redondo Beach, Calif.). J. Geophys. Res.; 77: No. 10, 1729-38(1 Apr 1972).

Explorer 33 and 35 magnetometers, on the western and eastern flanks of the Earth's bow shock, respectively, observed the boundary concurrently between 0130 and 0430 UT, October 30, 1968. Contrasting shock structures were recorded. Explorer 35 saw a quiet abrupt shock, whereas Explorer 33 saw an irregular noisy boundary with much upstream wave activity. The interplanetary field was roughly in the average archimedean spiral angle and was therefore approximately tangent to the shock at Explorer 35 and normal to the shock at Explorer 33. Gross motions and variable tilting of the aberrated shock probably contributed to the peculiar sequence of shock crossings at the two spacecraft. The observations support a model of the shock in which perpendicular and oblique collisionless structures coexist and form a nonuniform magnetosheath outer boundary. (25 references) (auth)

31945 ELECTRON-DENSITY PROFILES DEDUCED FROM PLASMAPAUSE WHISTLERS OBSERVED IN THE UNITED KINGDOM. Mathur, Ashok; Rycroft, Michael J. (Univ. of Southhampton, Eng.). J. Geophys. Res.; 77: No. 10, 1982-6(1 Apr 1972).

One of the most powerful methods of studying the density of thermal plasma in the magnetosphere is by means of the radio vlf radio signals produced by lightning discharges that propagate along geomagnetic-field lines from one hemisphere to the other through a dispersive medium. Observations using the whistler method were made on March 8 and July 2, 1970 and are believed to be the first from the United Kingdom. Results agree with previous data that the density of thermal plasma is reduced during a geomagnetic storm by a factor of ~2 within the plasmasphere and by more than an order of magnitude beyond the plasmapause; also the electron density decreases at the plasmapause by a factor of 100 within 0.2 R_E on a disturbed occasion, but only by a factor of about 17 within 0.4 R_E on a quiet occasion. The gradient, or sharpness, of the knee in the magnetospheric electron-density profile is directly proportional to geomagnetic activity. (J.C.W.)

31946 PROPAGATION OF A MAGNETOSPHERIC COMPRESSIONAL WAVE TO THE GROUND. Lanzerotti, L. J.; Tartaglia, N. A. (Bell Telephone Labs., Murray Hill, N. J.). J. Geophys. Res.; 77: No. 10, 1934-40(1 Apr 1972).

A detailed analysis indicates that a pure compressional wave in the magnetosphere at the equator was observed on the ground near the northern conjugate area as an attenuated nearly pure transverse wave. The plane of polarization of the wave was tilted down ~12° from the ground plane. Ground-based observations suggest that no proposed theory readily explains the occurrence of the magnetospheric wave (28 references) (auth)

31947 RING CURRENT IN THE MAGNETOSPHERE AND THE POLAR MAGNETIC SUBSTORMS. Troshichev, O. A. (Leningrad State Univ.); Feldshtein, Ya. I. J. Atmos. Terrest. Phys.; 34: No. 5, 845-58(May 1972).

Measurements of charged particles made in the ATS-1, OGO-3, and Explorer-34 satellites and simultaneous measurements of the magnetic field at the ground are used to investigate the temporal–spatial characteristics of some magnetic storms. The following conclusions are reached: (1) The low-energy protons ($5 \leq E \leq 50$ keV) observed by Frank in space cannot be the initial cause of the development of magnetic disturbances at the Earth's surface. (2) To separate spatial and temporal variations of particle intensities it is necessary to use both ground-based and satellite data. It is then possible to define the parameters of the ring current responsible for the decrease of the geomagnetic field. (3) The low-latitude bays that occur during polar disturbances may be explained by a partial ring current flowing outside the region of stable trapping. (4) The diamagnetic effect of ring-current particles is responsible for the decrease of the magnetic field at satellite orbits. The simultaneity of the magnetic disturbance development at the satellite and at the Earth's surface is explained by the variation of the incoming particle density. (5) The changes in the current system responsible for a high-latitude magnetic disturbance are traced. It is shown that an almost single-vortex current structure (the westward electrojet) occurs during the maximum of the substorm, and a twin-vortex structure is observed during the onset of the disturbance development and during the recovery phase. (auth)

31948 POTENTIAL PRODUCED BY A PULSATING POINT CHARGE IN A COLD HOMOGENEOUS MAGNETOPLASMA. Chasseriaux, J. M. (CNRS, Saint-Maur-des-Fosses, France). Ann. Geophys.; 27: No. 3, 329-37(Jul 1971). (In French).

In the theory of quadrupole plasma probes, a knowledge of the potential set up in a magnetosphere by a stationary sinusoidally pulsating point charge is of fundamental importance. This potential is derived for a cold, homogeneous, and boundless magnetoplasma in the general case, where the coefficients of the permittivity tensor are complex. The phase of this potential is studied for the case in which collisions are negligible. (France)

Solar Wind and Cosmic Ray Interactions

Refer also to abstracts 31709, 31871, 31872, 31924, and 32492.

31949 (AD-734435) QUASI-LINEAR INTERACTION OF WHISTLER-MODE WAVES AND NONTHERMAL ELECTRONS. Fung, P. C. W. (Stanford Univ., Calif. Inst. for Plasma Research). Nov 1971. Contract N00014-67-A-0112-0062. 51p. (SU-IPR-444). NTIS.

The quasi-linear cyclotron instability (under the weak turbulence regime) for whistler-mode waves due to pitch-angle anisotropy of nonthermal electrons was investigated. The motivation of this study was to explain the triggered discrete vlf emissions occurring in the terrestrial magnetosphere. The time evolution of the growth rate and the induced-waves spectrum for a loss-cone type of nonthermal electrons is analyzed numerically. The diffusion of particles in pitch angles due to quasi-linear cyclotron instability is illustrated. It is shown that several major features of triggered vlf emissions can be explained by the stated instability. (auth) (NTIS)

31950 (KFKI-71-79) TRANSIENT MODULATION. Somogyi, Antal J. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1970]. 19p. (CONF-710807-2). Dep. NTIS (U. S. Sales Only).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971).

A summary was made of the papers dealing with the problems of Forbush decreases or cosmic-ray intensity variations due to large-scale quasi persistent azimuthal asymmetry in the solar wind. Forbush decrease data include all kinds of cosmic-ray storms and azimuthal asymmetry variations covers the 27-day variation and other recurrent variations with a time scale more than a few days and less than a few months. The most interesting result in the field of modulation dynamics is the general character of N-S asymmetries brought out in the fact that in almost all cases the equilibrium of the interplanetary space is perturbed, a marked gradient perpendicular to the ecliptic plane is produced. There is some indication that this holds not only in violent cases such as shock waves but also in weak perturbations like those giving rise to a 27-day wave. (J.C.W.)

31951 (N-72-14727) STOPPING RATE OF NEGATIVE COSMIC-RAY MUONS NEAR SEA LEVEL. Spannagel, G.; Fireman, E. L. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Dec 1971. 18p. (NASA-CR-115311; SAO-111-98). NTIS.

A production rate of 0.065 ± 0.003 ^{37}Ar atom/kg min of ^{39}K at 2-mwe depth below sea level was measured by sweeping argon from potassium solutions. This rate is unaffected by surrounding the solution by paraffin and is attributed to negative muon captures and the electromagnetic interaction of fast muons, and not to the nucleonic cosmic-ray component. The ^{37}Ar yield from ^{39}K by the stopping of negative muons in a muon beam of a synchrocyclotron was measured to be 8.5 ± 1.7%. The stopping rate of negative cosmic-ray muons at 2-mwe depth below sea level from these measurements and an estimated 17% electromagnetic production is $0.63 \pm 0.13\ \mu^-$/kg min. Previous measurements on the muon stopping rate vary by a factor of 5. The value is slightly higher but is consistent with two previous high values. The sensitivity of the Ar-37 radiochemical method for the detection of muons is considerably higher than that of the previous radiochemical methods and could be used to measure the negative muon capture rates at greater depths. (auth) (STAR)

31952 (TRITA-EPP-71-1) TRANSONIC DECELERATION OF THE SOLAR WIND VIA PLANETARY, COMETARY OR INTERSTELLAR GAS. Wallis, Max (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Feb 1971. 29p. Dep. NTIS (U. S. Sales Only).

Transonic behavior of plasma flows with ionization is investigated on two descriptions. On the single-fluid description, spherically symmetric shock-free solutions are produced, such as would describe the solar-wind interaction with neutral H (density N atoms/cm^3 outside about 10 a.u.). The shock-free solutions are valid for $10 \gtrsim N \gtrsim 1$, when sonic conditions are attained at a distance about 120 N^{-1} a.u. For $N \lesssim 1$, which interstellar wind explanations of the Lyman-α observations predict, cosmic-ray effects could control the transonic flow in a turbulent transition region—the "buffer" shell at around 100 a.u. invoked to explain the long-period hysteresis—if the diffusion coefficient is as small as 10^{22} to 10^{23} cm^2 sec^{-1}. The two-fluid description is appropriate for the solar-wind interaction with the Venusian and cometary atmospheres, when the new ions intrinsically form a subsonic species. The absence of a bow shock ahead of Venus can be explained via this subsonic species, whether or not shock-free solutions exist in the single-fluid picture. (auth) (Sweden)

31953 TWO-SATELLITE OBSERVATION OF SPATIAL AND TEMPORAL PARTICLE FLUX VARIATIONS OVER THE POLAR CAPS. Domingo, V.; Page, D. E. (European Space Research and Tech. Centre, Noordwijk, Netherlands). J. Geophys. Res.; 77: No. 10, 1971-5(1 Apr 1972).

Evidence is presented for the existence during the Nov. 2, 1969 solar-particle event of a preferred impact zone over the north polar cap for a few hours after the start of the event. Two identical, magnetically stabilized, near-Earth polar orbiting satellites were passing over the north pole during the solar event. The separation of the two satellites above the polar cap allows for an assumption that variations are probably of a temporal rather than a spatial nature. If the observations of Hudson and Anderson (1969), indicating that the short-term fluctuations observed over the polar caps are not due to fluctuations in the interplanetary particle flux, can be applied to this event, it is necessary to conclude that the source of the variations is magnetospheric. A scheme is given for establishing the source. (J.C.W.)

31954 EXPLORER 35 OBSERVATIONS OF SOLAR-WIND ELECTRON DENSITY, TEMPERATURE, AND ANISOTROPY. Serbu, G. P. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 77: No. 10, 1703-12(1 Apr 1972).

Measurement of the electron integral spectrum yields electron temperatures ranging from 1 to 4 × 10^5°K and having an average value of 1.82 × 10^5°K, electron densities having an average value of 4.6 cm^{-3}, and electron-temperature anisotropies ranging from 1 to 1.4. The electron temperature is found to be independent of solar-wind speed over the range of 290 to 675 km sec^{-1}. Comparison of the simultaneous alignment of the local magnetic-field vector with the direction of the electron-temperature anisotropy reveals a high correlation. Necessary conditions for the firehose instabilities were satisfied in the electron and proton components of the solar-wind plasma immediately behind an interplanetary shock. (25 references) (auth)

31955 TRAPPING REGIONS FOR COSMIC RAY TRAJECTORIES IN THE MAGNETOSPHERE. Viswanathan, K. S. (Kerala Univ., Trivandrum, India); Revathi, K.; Rajappa, N. Indian J. Pure Appl. Phys.; 9: No. 11, 1013-16(Nov 1971).

The nature of the allowed regions for cosmic-ray particles in the energy range 1 to 15 GeV is studied by determining the roots of a cubic equation representing the motion of charged particles in the geomagnetic field. An analytical formula for the radial distance is derived for the motion in the meridian plane. The real positive roots of the cubic equation are evaluated numerically for particles having energy in the range 1 to 15 GeV and for different values of the associated parameters. Unlike the case of the auroral electrons or particles in the radiation belts, the Störmer unit of distance is small for cosmic-ray particles and three real positive roots are possible, giving three kinds of trapping regions. It is shown that, as the latitude increases, allowed regions appear, and the characteristics of the trajectory of cosmic-ray particles for different values of the associated parameters are discussed. (auth)

31956 SOLAR WIND FOR A MAGNETIZED PLASMA WITH TENSOR PLASMA PRESSURE. Tan, Muser; Abraham-Shrauner, Barbara (Washington Univ., St. Louis). Cosmic Electrodyn.; 3: No. 1, 71-80(Apr 1972).

A solar-wind model for a magnetized solar wind is presented using one-fluid hydromagnetic equations with generalized polytrope equations of state for the two-tensor components of the plasma pressure. Fluid and magnetic-field variables are calculated at the Earth using certain boundary conditions at the Sun. The azimuthal velocity agrees with observed values and explains the considerable loss of angular momentum from the Sun by the solar wind. The results are good for most variables but suggest that a two-fluid model with electrons at higher temperatures and smaller temperature anisotropy ratios than the ions would give improved agreement for some quantities. (auth)

31957 TWO-DIMENSIONAL EQUILIBRIUM SOLUTION OF THE PLASMA SHEET AND ITS APPLICATION TO THE PROBLEM OF THE TAIL MAGNETOSPHERE. Toichi, Tsutomu (Tokyo Univ.). Cosmic Electrodyn.; 3: No. 1, 81-96(Apr 1972).

Two-dimensional self-consistent solutions are obtained that are appropriate to describe the structure of the plasma sheet in the magnetosphere. It is shown that due to thinning of the plasma sheet the tail magnetosphere becomes more tail-like field configuration and the particle number in the plasma sheet decreases. At the same time the density gradient of the plasma sheet becomes steeper and the drift velocity of the particles increases. These are compared with the satellite magnetic-field and plasma observations. (auth)

PHYSICS (ATOMIC AND MOLECULAR)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstract 32655.

31958 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 7, NO. 2, 1972. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 49p.

This listing contains 178 references on various aspects of the subject. (M.O.W.)

31959 ATOMIC CHARGE STATE RATIOS OF ^{16}O IONS FROM 18.7 TO 59.7 MeV. Stocker, H.; Berkowitz, E. H. (Univ. of Notre Dame, Ind.). Can. J. Phys.: 49: No. 11, 1536-9(1 Jun 1971).

Charge state fractions, 5+, 6+, 7+, and 8+, of high-energy ^{16}O ions between 18.7 and 59.7 MeV were measured and ratios of charge-state fractions differing by one charge unit were found to follow an inverse fourth-power dependence. The average ionic charge of a ^{16}O beam varies from 6.4 to 7.6 over this range. (auth) (Canada)

31960 ELECTRON EMISSION FROM SOLIDS BY PARTICLES CARRYING POTENTIAL ENERGY. Hagstrum, H. D. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 193-204 of Phenomena in Ionized Gases, 1971. /Davenport, P. A. (ed.). Oxford; Donald Parsons and Co. Ltd. (1971).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

It is stated that if an electronic transition process occurring at a solid surface ejects electrons by means of potential energy furnished by an incident atom or molecule the process must be of Auger type and will always involve either de-excitation of an electrically excited particle or neutralization of an ionized particle. Each of these events will make energy available to a second electron of the solid-particle complex, which will become excited and, if properly directed and sufficiently energetic, will leave the solid. A topic is discussed that may be of interest in investigation of the phenomena of ionized gases: this is the validity of the potential energy diagram and the Franck–Condon principle in delineating the energetics of Auger ejection processes at solid surfaces. First of all a review is given on what is known concerning the process of Auger neutralization of singly charged ions and the Auger de-excitation of excited atoms. Recent work on ejection processes for the He^+ (2s) excited ion and the He^{++} ion is then discussed. (16 references) (UK)

Atomic and Molecular Properties

Refer also to abstracts 32076, 32347, and 32368.

31961 (CTO-799) NEUTRALIZATION OF ION BEAM SPACE CHARGE BY INJECTED ELECTRONS. Gabovich, M. D.; Soloshenko, I. A.; Ovcharenko, A. D. Translated by A. G. Cheney for Culham Lab., Abingdon, Eng., from Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 5, 813-22(1971). 6p. Dep. NTIS (U. S. Sales Only).

Neutralization of an ion beam space charge by electrons injected into the beam from a heated cathode is investigated. The injection of electrons into the beam is shown to result in a considerable decrease of the radial potential drop, and the beam converges to the axis. The minimum radial potential drop as a function of current and beam energy was studied. A qualitative estimate of this value was found to be in good agreement with experiment. (auth)

31962 (SC-DC-722273) L AND M-SHELL YIELDS AND ELECTRON SPECTRA FOR THE TRANSURANIC ELEMENTS. McGuire, Eugene J. (Sandia Labs., Albuquerque, N. Mex.). [1972]. 23p. (CONF-720404-4). Dep. NTIS.

From International conference on inner shell ionization phenomena; Atlanta, Ga. (17 Apr 1972).

Calculations on radiative, Coster–Kronig, and Auger transition rates, yields, and electron spectra for the elements Z = 92, 94, 96, 98, 100, and 103 are presented. Comparison is made with measurements on L- and M-shell yields and on the full width at half maximum for some radiative transitions in uranium. In certain cases agreement with experiment is found only by including (excluding) certain Coster–Kronig transitions that are ostensibly forbidden (allowed). In this context the energetics of the $L_2-L_3M_4$ transition at Z = 92, 94, and 96 are discussed. (auth)

31963 (UCRL-73630) MEASUREMENT OF RELATIVE K-RADIATIVE DECAY RATES. Slivinsky, V. W.; Ebert, P. J. (California Univ., Livermore. Lawrence Livermore Lab.). 20 Mar 1972. 26p. (CONF-720404-9). Dep. NTIS.

From International conference on inner shell ionization phenomena; Atlanta, Ga. (17 Apr 1972).

Relative K-radiative decay rates for elements between Z = 18 and 92 were measured. In the range $18 \leq Z \leq 39$, pure samples of thickness between 40 and 90 $\mu g/cm^2$ were evaporated onto 0.5 mg/cm^2 thick Be substrates. A strongly collimated x-ray beam from a Mo-target x-ray tube operated at 30 kV was filtered with 50 mg/cm^2 Mo and 140 mg/cm^2 Al. The transmitted x-rays (mainly Mo fluorescence) excited the samples, which were mounted in a vacuum. A Be window Si(Li) spectrometer with known efficiency was used to count fluorescent x rays. Spectrometer resolution was 185 eV at 6.4 keV, and for the lower-Z elements the fluorescent peaks had to be graphically separated. The data were corrected for scattered background, detector efficiency, Si escape peaks, Be x-ray transmission, and incomplete charge collection in the spectrometer (tailing), all of which were measured. These corrections were generally <2%, except for $18 \leq Z \leq 22$, where 3 to 6% corrections were applied. The total error was estimated to be 1% for all elements with $Z \geq 22$; the largest error was 6% at Z = 18. In the range $29 \leq Z \leq 92$, pure metal oxide samples <1 mg/cm^2 were supported by 2.5×10^{-4} cm thick mylar films. Appropriately filtered x rays from a W-target x-ray tube excited the samples in air. Sample thickness was determined by comparing count rates with those from foils of known thickness. A Ge(Li) spectrometer with known efficiency having a resolution of 550 eV at 60 keV was used to count the fluorescent x rays. For $Z \geq 62$, it was possible to resolve the K_{α_1}, K_{α_2}, $K_{\beta_1'}$ and $K_{\beta_2'}$ x-ray peaks. Some of the x-ray peaks were graphically separated, and the data were corrected for the effects mentioned above. For the larger peaks the corrections generally were <10%. Estimated experimental errors in peak areas were 1.5 to 6%. The K_β/K_α ratios for all elements are consistently higher than those predicted by Scofield, but show qualitative agreement in that the shapes of the K_β/K_α vs Z curves are similar. Both the calculation and the experiment show K_β/K_α to be relatively constant for $21 \leq Z \leq 30$, where the 3d levels are being filled. For $Z \geq 62$, the $K_{\alpha_2}/K_{\alpha_1}$ ratios are in excellent agreement with predictions, but the ratios $K_{\beta_1'}/K_{\alpha_1}$ and $K_{\beta_2'}/K_{\alpha_1}$ are consistently higher than predicted. (auth)

31964 MOLECULAR FORCE FIELDS OF TUNGSTEN AND URANIUM HEXACHLORIDES. Avasthi, M. N.; Mehta, M. L. (Univ. of Jodhpur, India). Z. Naturforsch.; 27a: No. 4, 700-1 (Apr 1972).

Molecular force field studies of tungsten and uranium hexachloride have been carried out using the Urey–Bradley force field (UBFF) and the orbital valence force field (OVFF). Weighted least square adjustment has been used to fit the observed frequencies. Comments are also made on the suitability of the force fields used. The trends in stretching force constants have been discussed. (auth)

31965 SQUARE OF THE RADIAL INTEGRAL FOR CALCULATING THE DIPOLE OSCILLATOR STRENGTHS FOR TRANSITIONS IN HYDROGEN ATOMS IN THEIR 3(s, p, OR d) AND 4(s, p, d, OR f) STATES. Khandelwal, G. S.; Fitchard, E. E. (Old Dominion Univ., Norfolk, Va.). Astrophys. J.; 173: No. 3, 737-40(1 May 1972).

Explicit expressions for the square of the radial integral associated with the dipole oscillator strengths for transitions in hydrogen atoms in their 3(s, p, or d) and 4(s, p, d, or f) states are obtained from Gordon's general formula. Numerical values of the square of the radial integrals are tabulated for $10 \leq n \leq 60$. The radial integrals are asymptotically expanded to order $1/n^9$ to facilitate calculations for large n. (auth)

31966 RELATIVISTIC CALCULATIONS OF (r^{-3}) AND OTHER (r^n) PARAMETERS ENCOUNTERED IN MAGNETIC RESONANCE OF RARE-EARTH IONS AND ATOMS. Lewis, W. Burton (Los Alamos Scientific Lab., N. Mex.). pp 717-22 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

Matrix elements of $\langle r^{-3} \rangle$ for Sm were calculated with relativistic Hartree–Fock–Slater (HFS) wave functions by Rosén (J. Phys. B (London), 2: 1257(1969)) and Lewis et al. (J. Chem. Phys., 53: 809(1970)). Included in the latter work are similar calculations for Eu and matrix elements for other r^n functions. derived from Hartree–Fock as well as HFS wave functions. These calculations are extended here to all of the rare-earth atoms and ions using the relativistic HFS or Dirac–Slater wave functions, and results are presented in three tables. (auth)

31967 DIFFERENCE IN ENERGY BETWEEN SINGLET AND TRIPLET STATES. Kohl, D. A. (Univ. of Texas, Austin). J. Chem. Phys.; 56: No. 8, 4236-8(15 Apr 1972).

The behavior of wave functions for the lowest excited singlet and triplet states of the helium atom is examined. The diagonal components of the first- and second-order density matrices were used for the comparison. The results are interpreted in terms of the relative contributions of nuclear attraction and electron–electron repulsion to the total energy. (A.G.W.)

31968 VARIATIONAL WAVE FUNCTIONS FOR H_2^+. Weinhold, Frank; Chinen, Allan B. (Stanford Univ., Calif.). J. Chem. Phys.; 56: No. 8, 3798-3801(15 Apr 1972).

The usual approximations to the molecular orbitals of H_2^+ are shown to have an improper exponential dependence on the radial elliptic coordinate λ. However, the exact λ dependence is easily incorporated into simple trial functions and leads to substantially improved numerical accuracy for both the $1s\sigma_g$ and $2p\sigma_u$ states. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 30848, 32713, and 32714.

31969 UMKLAPP ANNIHILATION OF POSITRONIUM IN CRYSTALS. Hodges, C. H.; McKee, B. T. A.; Triftshaeuser, W.; Stewart, A. T. (Queen's Univ., Kingston, Ont.). Can. J. Phys.; 50: No. 2, 103-9(15 Jan 1972).

Previous experiments with positron annihilation in single crystals of quartz have revealed an interesting series of narrow peaks in the momentum distribution of the annihilation photons. Present experiments repeat these observations and also confirm that no very long lifetime exists. A simple theoretical model based upon the necessity of treating the positronium electron and the remaining electrons in the crystal as indistinguishable is outlined. The model yields results compatible with both momentum and lifetime data. (auth) (Canada)

31970 CHEMISTRY OF THE POSITRON AND OF POSITRONIUM. Ache, Hans J. (Virginia Polytechnic Inst. and State Univ., Blacksburg). Angew. Chem. Int. Ed. Engl.; 11: No. 3, 179-99(Mar 1972).

In this progress report, the properties and behavior of the positron and of positronium, a "hydrogen atom" containing a positron instead of a proton, are considered from the chemist's viewpoint. Examples are given to demonstrate the development of positronium chemistry, in aqueous solution and in the gaseous, liquid, and solid phases, with its problems and possibilities. (71 references) (auth)

Collision Phenomena

31971 (ANL–7904) EMPIRICAL REPRESENTATION OF PHOTOELECTRIC CROSS SECTIONS. Smith, Donald L. (Argonne National Lab., Ill.). Jan 1972. Contract W-31-109-eng-38. Dep. NTIS.

The problem of providing empirical fits to tabulated photoelectric cross sections is discussed, and two formulas that may be used for this purpose are recommended. These formulas are: $\sigma_1(E_\gamma) = \Sigma_{k=1}^{n_1} a_k E_\gamma^{1-k}$, and $\sigma_2(E_\gamma) = \exp[\Sigma_{k=1}^{n_2} b_k (\ln E_\gamma)^{k-1}]$. (auth)

31972 (SRI–115-P-78-9) FUNDAMENTAL PRINCIPLES OF COLLISION SPECTROSCOPY IN DIATOMIC SYSTEMS. Final Report, December 1, 1968–December 31, 1971. Olson, Ronald E.; Smith, Felix T. (Stanford Research Inst., Menlo Park, Calif.). 31 Dec 1971. Contract AT(04-3)-115. 80p. Dep. NTIS.

Work done on a study of fundamental principles of collision spectroscopy and methods for interpretation of collision spectra in diatomic systems is summarized briefly. Papers on the following are included as appendices: inelastic scattering of He^+ by Ar, low-energy theoretical inelastic differential scattering cross sections for the process $He^+ + He \rightarrow He^+ + He(2^3S)$, and molecular and atomic boundary conditions for atomic collision problems. (A.G.W.)

31973 (UCRL–73823) PRODUCTION OF CHARACTERISTIC X RAYS BY HEAVY ION BOMBARDMENT. Kavanagh, T. M.; Fortner, R. J. (California Univ., Livermore. Lawrence Livermore Lab.). 22 Mar 1972. 22p. (CONF-720404–8). Dep. NTIS.

From International conference on inner shell ionization phenomena; Atlanta, Ga. (17 Apr 1972).

Data on inner-shell vacancy production in heavy-ion–atom collisions, as obtained from x-ray measurements, are reviewed. Cross-section data and results of spectral measurements are discussed and related to a parameter E/λu that indicates the degree of adiabaticity of the interaction. Interaction mechanisms are examined in this context. (12 references, 8 figures) (auth)

31974 BROADENING AND SHIFT OF ATOMIC LINES PRODUCED BY FAST ELECTRON COLLISIONS. Bassalo, J. M.; Cattani, M. (Univ. of Sao Paulo, Brazil). Can. J. Phys.; 50: No. 2, 151-7(15 Jan 1972).

General expressions for the width and shift of atomic lines produced by fast electron collisions are obtained, using the recent quantum-mechanical theories developed to explain the pressure line shape in the impact approximation. Only isolated and Lorentzian lines are analyzed. The calculations are performed by expanding the scattering matrix up to the second Born approximation. The contributions of both elastic and inelastic virtual collisions are calculated. Degenerate and nondegenerate atomic states are considered. (auth) (Canada)

31975 APPROXIMATE SOLUTION OF THE TIME-DEPENDENT SCHROEDINGER EQUATION IN THEORY OF COLLISIONS. Chapuisat, X.; Bergeron, G. (Paris Univ., Orsay, France). Chem. Phys. Lett.; 13: No. 4, 349-56(15 Mar 1972).

An approximate solution of the time-dependent Schrödinger equation is introduced, which is closely related to the semi-classical description of strong-coupling collision problems. This method is intended to reduce computer time by taking into account the fact that many numerical elements may be common to all the calculations that correspond to differential initial conditions for the same physical system. The foreseen applications lie in the field of atomic and molecular scattering problems. (auth)

31976 CHARGE-IMPACT EXCITATION OF THE HIGHLY EXCITED HYDROGEN ATOMS IN THE DIPOLE FORM OF THE SEMICLASSICAL IMPACT-PARAMETER AND BORN APPROXIMATIONS. Omidvar, Kazem (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 173: No. 3, 731-6(1 May 1972).

Expressions for the excitation cross section are derived in the dipole approximation of the semiclassical impact parameter and the Born approximations, making use of a formula given by Menzel for the asymptotic expansion of the oscillator strength of the hydrogen-like atoms. When only the leading term in the asymptotic expansion is retained, the expression for the cross section becomes identical with the expression obtained by the method of the classical collision and correspondence principle given by Percival and Richards. Comparisons are made between the Bethe coefficients obtained here and the Bethe coefficients of the Born approximation for transitions where the Born calculation is available. Satisfactory agreement is obtained only for $n \rightarrow n + 1$ transitions, where n is the principal quantum number of the excited state. (auth)

31977 HYDROGEN-XENON POTENTIAL-ENERGY FUNCTION DETERMINED FROM HIGH-ENERGY ELASTIC SCATTERING. Picot, Monique; Fink, Richard D. (Amherst Coll., Mass.). J. Chem. Phys.; 56: No. 8, 4241-2(15 Apr 1972).

The variation in the total average cross section for small-angle elastic scattering of atomic beams of hydrogen by xenon was measured as a function of energy over the energy range 500 to 1400 eV. A classical analysis of the data was carried out. Results are summarized in the determination of the parameters K and s in the assumed form of the atom–atom potential-energy function $V(r) = K/r^s$. The expression obtained for this function is $V(r) = 36.13/r^{5.38}$ in the range $1.95 < r < 2.23$ Å. (A.G.W.)

31978 PRODUCTION OF EXCITED STATES IN THE COLLISION OF He^+ WITH HCl AND HBr: SELECTIVE PRODUCTION OF THE $v = 0$ LEVEL IN THE A $^2\Sigma$ STATE OF THE MOLECULE-ION. Haugh, M. J. (Temple Univ., Philadelphia). J. Chem. Phys.; 56: No. 8, 4001-10(15 Apr 1972).

The emission of light over the 2000- to 6000-Å wavelength region resulting from the collision of the He^+ ions on HBr and HCl was investigated at ion energies from 0.3 to 4.0 keV. Emission is observed from the A $^2\Sigma \rightarrow$ X $^2\Pi_i$ transition of HBr^+ and HCl^+, from atomic hydrogen, and from Br^+ and Cl^+ ions. Relative cross sections were determined for the formation of individual H-atom quantum levels and vibrational levels of the molecular ion. Vibrational populations were proportional to the Franck–Condon factors for a transition between the neutral ground state and the A $^2\Sigma$ state. An unusual dependence upon target gas pressure was observed for the intensity of the (0, 0) band of HCl^+ and HBr^+. The intensity increases quadratically with target gas pressure in the 10^{-4}-torr region. Similar studies of other ions impinging on HCl and HBr do not show this effect. The most plausible mechanism satisfying all of the experimental observations is that two molecules of target gas are involved in the excitation process. In the first step He^+ reacts with HCl or HBr to form a reactive intermediate that subsequently reacts with a second molecule to produce the A $^2\Sigma$ state of the molecular ion in the v = 0 level only. (auth)

31979 FORMATION AND COLLISIONAL DISSOCIATION OF HETERONUCLEAR RARE-GAS ASSOCIATIVE IONS. Kramer, H. L.; Herce, J. A.; Muschlitz, E. E. Jr. (Univ. of Florida, Gainesville). J. Chem. Phys.; 56: No. 8, 4166-70(15 Apr 1972).

Ratios R of the cross sections for associative to the sum of associative and Penning ionization were measured using molecular beams of thermal-energy (330°K) metastable atoms, A^*, incident on a gas B confined in a collision chamber at low pressures, where A^* is either $2^{1,3}S$ helium or $^3P_{2,0}$ neon and B is argon or krypton. By determining R as a function of the collision chamber pressure in the range 0.05 to 0.4 μ and by measuring the relative intensity of the secondary product ion, B_2^+, cross sections σ_I and σ_{II} for destruction of the associative ions, $AB^+ + B \rightarrow A + B^+ + B$ and $AB^+ + B \rightarrow A + B_2^+$, were determined. Extrapolation to zero pressure gives the true value of R for the primary processes. The effect of a change in the ratio of $2^1S/2^3S$ helium in the metastable-atom beam was also investigated by changing the energy of the exciting electron beam. In collisions of He^* with both argon and krypton, R is greater for 2^3S helium than for 2^1S helium by about 0.05. Within the experimental error, σ_I and σ_{II} for destruction of AB^+ are independent of whether this ion is formed by collisions of 2^3S or 2^1S helium. The large size of the cross sections σ_I, which range from 210 Å^2 for $NeAr^+$–Ar to 470 Å^2 for $HeKr^+$–Kr, suggests that the associative ions are formed very close to the dissociation limit. (auth)

31980 LOW-ENERGY ELECTRON ATTACHMENT TO OZONE USING SWARM TECHNIQUES. Stelman, D.; Moruzzi, J. L.; Phelps, A. V. (Westinghouse Research Labs., Pittsburgh). J. Chem. Phys.; 56: No. 8, 4183-9(15 Apr 1972).

The rate coefficients for the attachment of low-energy electrons to ozone were measured using the drift-tube technique. The rate coefficients obtained in pure ozone at 300°K and in ozone–carbon-dioxide mixtures at 200 and 300°K are consistent with a two-body attachment process that is independent of temperature. The rate coefficients measured in O_3–CO_2 mixtures can be expressed as $(1.9 \pm 0.4) \times 10^{-9} (\epsilon_K)^{1.46}$ cm^3/s for characteristic electron energies ϵ_K between 0.02 and 0.3 eV. This result is used to derive an energy-dependent cross section for electron attachment to O_3 for comparison with the electron-beam data. (auth)

31981 DIFFERENTIAL MEASUREMENTS OF DISSOCIATIVE CHARGE EXCHANGE, $He^+ + CO_2$. Coplan, M. A.; Ogilvie, K. W.; McMillan, M. (Univ. of Maryland, College Park). J. Chem. Phys.; 56: No. 8, 4223-6(15 Apr 1972).

Measurements of the angular distributions and energies of the charged products of the dissociative charge-exchange collision between helium ions and carbon dioxide were made over the range of incident ion energies 100 to 500 eV. The angular distributions in the laboratory system show two maxima. The average energies of the ions corresponding to the two maxima differ by a significant amount. The data can be explained in terms of two different dissociative charge-exchange mechanisms, and there is evidence that certain orientations of the carbon dioxide molecule with respect to the helium ion beam are favored in the charge-exchange process. (auth)

31982 FORMATION OF NEGATIVE IONS BY DISSOCIATIVE ATTACHMENT IN H_2S. Azria, R.; Tronc, M.; Goursaud, S. (Paris Univ., Orsay, France). J. Chem. Phys.; 56: No. 8, 4234-5(15 Apr 1972).

The variation with electron energy of the total ionization cross section resulting from dissociative electron attachment in H_2S was measured. The ionization efficiency curve shows four peaks. The first peak is essentially H^- with a small contribution of S^-. The third and fourth peaks cannot be definitely analyzed by the method used, but possible interpretations are considered. Deuterium isotope effects were measured and found to be: $(S^-/HDS)/(S^-/H_2S) = 0.58 \pm 0.07$ and $(S^-/D_2S)/S^-/H_2S) = 0.37 \pm 0.02$. (A.G.W.)

31983 ANHARMONIC COHERENT RAMAN SCATTERING IN H_2. Lukasik, J.; Ducuing, J. (Paris Univ., Orsay, France). Phys. Rev. Lett.; 28: No. 18, 1155-8(1 May 1972).

The direct observation of anharmonic effect in coherently driven molecular vibrations is reported for low-pressure H_2. Under intense excitation of the gas by light waves of frequencies ω and ω′, both electrical and mechanical anharmonicities contribute to a coherent polarizability modulation at $2(\omega - \omega')$. The corresponding anharmonic scattering dominates, at low pressure, the usually observed harmonic double scattering. Application of the effect to the determination of the second-order polarizability derivative is discussed. (auth)

31984 ANGULAR DEPENDENCE OF ELECTRON-IMPACT EXCITATION CROSS SECTIONS OF O_2. Trajmar, S.; Williams, W.; Kuppermann, A. (Califonria Inst. of Tech., Pasadena). J. Chem. Phys.; 56: No. 8, 3759-65(15 Apr 1972).

The electron-impact excitation spectrum of O_2 was studied at impact energies of 20 and 45 eV and at scattering angles ranging from 10 to 90°. The angular behavior of the differential scattering cross sections for excitation of the a $^1\Delta_g$, b $^1\Sigma_g^+$, B $^3\Sigma_u^-$ states, for the 9.97-eV ("longest" band), and the 10.29-eV ("second" band) transitions, for the broad feature at 6.1 eV energy loss (previously assigned to the excitation of the A $^3\Sigma_u^+$ state), and for elastic scattering was determined. The experimentally measured relative differential and integral cross sections for these processes were approximately normalized to the absolute scale. The intensities of the different transitions in optical and electron-impact spectra are compared and the importance of spin–orbit coupling and exchange processes are discussed. It is found that the energy-loss feature at 6.1 eV in the electron-impact spectrum is mostly due to the excitation of the c $^1\Sigma_u^-$ state. This new assignment is supported by the angular and energy dependence of the scattering cross section (and by the intensity pattern found in various electron-impact processes). (auth)

31985 APPLICATION OF THE EIKONAL APPROXIMATION TO ELECTRON SCATTERING. I. ELASTIC SCATTERING FROM SPHERICALLY SYMMETRIC POTENTIALS. Duncan, D. P.; Tuley, F. H. Jr.; Kohl, D. A. (Univ. of Texas, Austin). J. Chem. Phys.; 56: No. 8, 3766-9(15 Apr 1972).

A form of the eikonal approximation is presented, which is slightly different from the familiar one found in the literature, but which reduces to it in the appropriate limit. The object of the paper is to investigate the possibility of using the eikonal theory to study processes that cannot be easily nor accurately studied by methods currently available. It is found that the eikonal theory is quite successful in reproducing partial wave results for elastic scattering on spherically symmetric potentials, and it is then proposed that it be used to study inelastic scattering processes for atoms and elastic processes for molecules. (auth)

31986 APPLICATION OF THE EIKONAL APPROXIMATION TO ELECTRON SCATTERING. II. INELASTIC SCATTERING FROM HELIUM. Kohl, D. A.; Duncan, D. P.; Tuley, F. H. Jr.; Fink, M. (Univ. of Texas, Austin). J. Chem. Phys.; 56: No. 8, 3769-72(15 Apr 1972).

The eikonal approximation is applied to the electron-impact excitation of the 2 ^1S and 2 ^1P states of helium for incident energies of 50 to 500 eV. The differential cross sections for both excitations deviate significantly from the first Born approximation calculation. The results are compared with experimental cross sections. (auth)

31987 ELASTIC SCATTERING OF LOW-ENERGY ELECTRONS IN THOMAS–FERMI THEORY. Tietz, T. (West Virginia Univ., Morgantown). Z. Naturforsch.; 26a: No. 6, 1054-7 (Jun 1971).

A detailed study was made of the elastic scattering of low-energy electrons in Thomas–Fermi theory. The analytical expressions obtained for the scattering length a and the total cross section σ are illustrated numerically. (auth)

31988 BROADENING OF THE HYDROGEN LINE Ly-α BY STRONG ELECTRON COLLISIONS. Pfennig, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Z. Naturforsch.; 26a: No. 6, 1071-87(Jun 1971). (In German).

A study of the effects of strong electron collisions on the profile of the line core is made within the framework of the impact theory. To this end the time-dependent Schrödinger-equation describing the change of state of the atom during the passage of one perturbing electron is solved numerically down to impact parameters equal to the de Broglie wavelength $\lambdabar$. In this range the classical description of the perturbing electrons is assumed to be still valid. In the dipole-only case, the solution can be expressed exactly by elementary functions. The line profile clearly shows how important it is to consider the strong collisions. All the different ways of doing this lead to nearly the same results. (auth)

31989 RESONANCES AND PSEUDORESONANCES IN THE KOHN VARIATIONAL METHOD AND THE FESHBACH METHOD. Shimamura, Isao (Tokyo Univ.). J. Phys. Soc. Jap.; 31: No. 3, 852-70(Sep 1971).

An operator formalism of the general single-channel Kohn method is developed, and Schwartz's theory of singularities in the Kohn method is generalized; any approximation method described in the framework of the Kohn method is shown to have, in general, singularities, some of which may correspond to true (either closed-channel or shape) resonances. Caution is urged against simple interpretation of "resonance results" of close-coupling calculations and other expansion methods. The Feshbach QHQ eigenvalues are shown to be approximations to the positions of the Kohn-method singularities. A correction to the Schwartz theory leads to the Harris method. Precisely at the characteristic Harris eigenvalues, the Hulthén condition $\langle\Psi|E - H|\Psi\rangle = 0$ cannot be satisfied in general, though, as was shown previously, a well-defined limiting value (which is equal to the Harris value and has a first-order error contrary to a variational phase shift) of the Hulthén phase shift exists. An elaborate Kohn-method calculation of e + H elastic scattering produces the lowest singlet resonance position, which gives the level shift of 1.0×10^{-5} Rydberg from the autoionizing-state energy calculated by Bhatia, Temkin, and Perkins. (auth)

31990 QUASIMOLECULAR STATE INTERFERENCE IN COLLISIONS BETWEEN RUBIDIUM IONS AND ARGON. **Bobashev, S. V.; Ogurtsov, V. I.; Razumovskii, L. A. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 62: No. 3, 892-5(Mar 1972). (In Russian).**

The cross sections for excitation of argon resonance lines emitted in collisions between rubidium ions and argon are measured. The observed oscillatory structure of the cross sections is regarded as a new experimental confirmation of the effect of interference between quasi-molecular states in the ion–atom system. (auth)

31991 SINGULARITIES OF SCATTERING OF ATOMIC PARTICLES IN COLLISIONS INVOLVING THE EXCITATION OF INNER ELECTRON SHELLS. **Afrosimov, V. V.; Gordeev, Yu. S.; Nikulin, V. K.; Polyanskii, A. M.; Shergin, A. P. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 62: No. 3, 848-62(Mar 1972). (In Russian).**

Scattering of 10- to 180-keV atomic particles with collision diameters such that the inner electron shells intersect is investigated. A structure (singularities) of the differential scattering cross sections is observed in collisions between N^+, Ne^+, Ar^+, Kr^+, and Xe^+ ions and Ne, Ar, Kr, and Xe atoms. The position and shape of the singularities could be studied thanks to the high total angular resolution of 7.5′ ± 0.5′ and an accuracy ~0.5%. A correlation between the scattering singularities and vacancy formation in the inner shells is found; this indicates that the singularities may be a result of the multichannel nature of scattering. A simplified description of collisions by means of two effective terms is suggested: the "ground" term corresponds to excitation of only the outer electron shells and the "excited" term corresponds to additional excitation of the inner shells. The deviation angle and scattering differential cross section are calculated in the classical and quasi-classical approximations for each of the possible channels. The cross sections have maxima that qualitatively agree with the experimental scattering singularities. Effective interaction potentials are derived from the experimental scattering cross sections by the Firsov method. (auth)

31992 NEGATIVE IONS. Craggs, J. D. (Univ. of Liverpool). pp 59-83 of Phenomena in Ionized Gases, 1971. /Davenport, P. A. (ed.). Oxford; Donald Parsons and Co. Ltd. (1971).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

After a brief historical introduction, the following topics are discussed: single collisions—beam experiments; studies of swarms; negative ion–molecular reactions—mobilities, diffusion, and energies of negative ions; three-body attachment; and collisional detachment. (55 references) (UK)

31993 IONISATION THROUGH METASTABLE SPECIES. Niehaus, A. (Univ., Freiburg i. B.). pp 85-112 of Phenomena in Ionized Gases, 1971. /Davenport, P. A. (ed.). Oxford; Donald Parsons and Co. Ltd. (1971).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

The subject of this paper is that of ionization processes occurring in collisions of excited species with other atoms or molecules, thus: $A^* + B \rightarrow A + B^+ + e^- \rightarrow AB^+ + e^-$, and an outline is given of present knowledge on the physics of these reactions. Some recent experimental data on cross sections, and electron and ion energy distributions are also reported. Information is first given on the excited states themselves, as well as on their production and destruction by various possible processes other than the foregoing reactions. Amongst matters considered are the mechanisms of Penning ionization, absolute cross sections for thermal collisions, electron energy distributions (atoms), energy dependence of cross sections, and electron energy distributions (molecules). (23 references) (UK)

31994 INELASTIC COLLISIONS BETWEEN SLOW ALKALI-METAL OR ALKALINE EARTH IONS AND CADMIUM ATOMS. **Shpenik, O. B.; Zavilopulo, A. N.; Zapesochnyi, I. P. (Uzhgorod State Univ., USSR). Zh. Eksp. Teor. Fiz.; 62: No. 3, 879-91 (Mar 1972). (In Russian).**

Detailed investigations of excitation processes occurring during collisions between Li^+, Na^+, K^+, Rb^+, Cs^+, Mg^+, Ca^+, Sr^+, and Ba^+ ions and cadmium atoms were carried out at energies ranging from the threshold value up to 1000 eV. The effective cross sections for excitation of a number of lines emitted by the target atoms, incident ions, and magnesium atoms are determined. The cadmium spectral line excitation function is sensitive to the mass and nature of the impinging ions. Excluding barium, the line excitation functions for the resonance ion doublet components of alkaline earth elements are identical. Only the target atoms are excited in interactions between alkali metal ions and cadmium atoms; in collisions between Cd atoms and Ca^+, Sr^+, and Ba^+ ions both the target atoms and impinging ions are excited. The Mg^+ + Cd reaction proceeds with a high probability simultaneously along all three inelastic channels leading to excitation of the Cd and Mg atoms and Mg^+ ions. The efficiency of spectral line excitation is analyzed, and it is suggested that the fine-structure peaks observed in the optical line excitation functions are consequences of quantum mechanical interaction between two or more closely arranged inelastic channels of the reaction. (auth)

31995 EXPERIMENTAL STUDY OF THE TRANSFER OF POPULATION, ORIENTATION, AND ALIGNMENT BETWEEN ^{198}Hg AND ^{202}Hg DURING COLLISIONS OF THE SECOND KIND (6^3P_1, 6^1S_0). **Cheron, B.; Saintout, L. (Univ., Caen, France). J. Phys. (Paris); 32: No. 10, 751-8(Oct 1971). (In French).**

The effective cross section corresponding to the $^{198}Hg(6^3P_1) + {}^{202}Hg(6^1S_0) \rightarrow {}^{198}Hg(6^1S_0) + {}^{202}Hg(6^3P_1)$ excitation transfer reaction was measured. The transfer of orientation and alignment between these isotopes was studied using the zero-field crossing method (Hanle effect). The results obtained are compared with the theory. (France)

31996 POSITIVE ION PRODUCTION CROSS SECTIONS DURING COLLISIONS BETWEEN I^+ AND I_2^+ IONS AND ALKANE MOLECULES. L'Hote, J. P.; Abbe, J. C.; Paulus, J. M. (CNRS, Strasbourg). Compt. Rend., Ser. B; 274: No. 4, 237-40(24 Jan 1972). (In French).

The cross sections for formation of positive ions of methane, ethane, propane, n-butane, and isobutane by collisions of I^+ and I_2^+ (σ_{I^+} and $\sigma_{I_2^+}$) having energies between 1000 and 10 eV with the corresponding alkanes were measured by the charge collection method. σ_{I^+} increases with decreasing energy, whereas $\sigma_{I_2^+}$ varies slightly or decreases slowly with decreasing energy down to 100 eV and then drops very rapidly for smaller energies. (France)

Atomic Theory

Refer also to abstract 32219.

31997 NOTE ON EXCLUSION-PRINCIPLE-VIOLATING DIAGRAMS. **Hata, J. (Osaka City Univ.). Chem. Phys. Lett.; 13: No. 4, 361-4(15 Mar 1972).**

The energy denominator, obtained by Freed, of the propagator in the many-body theory for atomic problems is generalized by taking account of particle-line exclusion-principle-violating diagrams. (auth)

31998 EXACT SOLUTIONS TO THE COUPLED HARTREE–FOCK PERTURBATION EQUATIONS. **Alexander, Millard H.; Gordon, Roy G. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 56: No. 8, 3823-31(15 Apr 1972).**

A new method is presented for obtaining exact solutions to the time-dependent coupled Hartree–Fock perturbation equations. An iterative approach is chosen, relying on the Aitken δ^2 transformation to insure and accelerate convergence. At each iteration the resulting uncoupled inhomogeneous differential equations are solved using the technique previously presented by Alexander and Gordon, based on piecewise polynomial approximation of both the potential and the inhomogeneity. As a numerical application the frequency-dependent dipole polarizability of the helium atom is calculated within the coupled Hartree–Fock approximation. Comparison is made with the results of previous variational and numerical calculations. The method can be extended to the solution of integrodifferential equations arising in other areas of chemical physics. (auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

Refer also to abstract 32564.

31999 HALL EFFECT IN THE ELECTRODYNAMICS OF CONDUCTING MEDIA IN TURBULENT MOTION. Helmis, G. (Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphys.; 11: No. 5, 417-30(1971). (In German).

Ohm's law is generalized for a turbulent conducting medium, taking into consideration the Hall effect. It is presumed that the turbulence is homogeneous, isotropic, and mirror-symmetrical. For any given conductivity and Hall parameter, exact relations are derived assuming small turbulence velocity and weak space dependency of the electromagnetic fields. Terms for effective conductivity and Hall parameter are calculated for a special case. The generalized result shows that effects caused by turbulence decline with increasing Hall parameter; however, influence of the Hall effect decreases with increasing electric conductivity. (tr-auth)

32000 FALKNER-SKAN PROBLEM IN MAGNETOHYDRODYNAMICS. Hildyard, Lewis T. (Univ. of Leeds, Eng.). Phys. Fluids; 15: No. 6, 1023-7(Jun 1972).

The Falkner-Skan problem is extended to magnetohydrodynamic flow past a nonconducting body by imposing a magnetic field whose lines of force are parallel to the undisturbed streamlines. The magnetic-field boundary condition used by Gribben is shown to be inappropriate and results in the form of asymptotic series for large and small values of the magnetic Prandtl number are obtained. Numerical integration is used to establish the validity of the series in each case. (auth)

32001 MAGNETOHYDRODYNAMIC FLOW BETWEEN TWO ROTATING COAXIAL CYLINDERS UNDER RADIAL MAGNETIC FIELD. Arora, K. L.; Gupta, P. R. (Punjab Engineering Coll., Chandigarh, India). Phys. Fluids; 15: No. 6, 1146-8(Jun 1972).

An exact solution for the magnetohydrodynamic flow between two rotating coaxial (insulator) cylinders under a radial magnetic field was obtained, and the results are discussed graphically. (auth)

32002 STABILITY OF TANGENTIAL JUMPS OF MAGNETIC HYDRODYNAMICS IN THE FIELD OF GRAVITY. Tomaradze, G. D. Soobshch. Akad. Nauk Gruz. SSR; 65: No. 3, 563-6(Mar 1972). (In Russian).

The problem of the stability of tangential jumps in the magnetohydrodynamics in the presence of a field of gravity is considered. The total dispersion ratio is obtained. It is shown that instabilities present in a strong magnetic field are stabilized by the field of gravity, but in some cases this field extends the stability range. (auth)

32003 INTRINSIC EQUATIONS OF MAGNETOGASDYNAMICS. THE CASE OF AXIAL SYMMETRY. Ferrero, G. M. (Univ., Turin). Atti Accad. Sci. Torino, I. Cl. Sci. Fis., Mat. Natur.; 106: No. 2, 245-55(Mar-Apr 1972). (In Italian).

The intrinsic equations of magnetogasdynamics are used for the steady-state motion, with the assumption of axial symmetry, and the geometric-mechanical characteristics of motion are determined. Particularly, a rotatory motion in meridian planes is considered. (auth)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

32004 (ANL/HEP–7034, pp 73-96) POLARIZED TARGET EXPERIMENTS AT BERKELEY AND SLAC. Robrish, P. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr 1970.

From Symposium on polarization at high energy; Argonne, Ill. (15 Apr 1970).

Asymmetry measurements in polarized target experiments are described. Results are presented for ep → eN*, ep → ep, $\gamma p \to \pi^+ n$, and np → pn interactions. (L.B.S.)

32005 (BMBW-FBK–71-24) ANNUAL REPORT, 1970. (Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Dec 1971. 84p. (In German). Dep. NTIS (U. S. Sales Only).

At the II. Institut für Experimentalphysik a number of research groups are working on nuclear or elementary particle physics. Another group does solid state physics using the synchrotron radiation of DESY. In nuclear physics most of the effort is devoted to studies of reaction mechanisms, nuclear moments, and hyperfine interactions. The experiments are performed by means of a 3-MeV van de Graaff generator, a 30-MeV isochronous cyclotron, and radioactive sources. Elementary particle physics is done in close connection with research groups at DESY. Research is focused on production processes and reaction mechanisms of elementary particles. (32 figures, 5 tables) (auth)

32006 (LNF–71/96) OBSERVATION OF A BROAD PEAK IN THE PRODUCTION OF FOUR CHARGED PIONS BY e^+e^- COLLISIONS AROUND 1.6 GeV. Barbarino, G.; Ceradini, F.; Conversi, M.; (and others) (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 20 Dec 1971. 6p. Dep. NTIS (U. S. Sales Only).

The interaction $e^+ + e^- \to 2\pi^+ + 2\pi^-$ at a total energy of 1.2 to 2.4 GeV in colliding beams is studied. The cross sections and production of a ρ^1 meson of mass 1600 are discussed. (J.F.P.)

32007 (LNF-71/97) REACTION $e^+e^- \to \pi^+\pi^-\pi^+\pi^-$ AND THE ρ' MESON. Bramon, A.; Greco, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 20 Dec 1971. 7p. Dep. NTIS (U. S. Sales Only).

The production of $\rho'(1600)$ in $e^+ + e^- \to 2\pi^+ + 2\pi^-$ interactions in colliding beams is discussed. Partial widths for decays $\rho' \to \omega + \pi$, $\rho' \to \rho + \eta$, $\rho' \to K^* + K$, $\rho' \to$ 2 pseudoscalar mesons and $\rho' \to 2\pi^+ + 2\pi^-$ are found. From the last decay the cross sections for $e^+ + e^- \to 2\pi^- + 2\pi^+$ interactions are found. The widths of the decays $\rho' \to \rho + \pi^+(\pi^0) + \pi^-(\pi^0)$ are found, and the strength of the ρ'–γ coupling is estimated by adding all the decay rates to obtain a total width. The implications of this coupling on proton Compton scattering and vector meson photoproduction are briefly discussed. (J.F.P.)

32008 (LNF-71/100) HADRONIC PRODUCTION BY e^+e^- COLLISIONS IN THE GeV REGION (2E, TOTAL ENERGY $\geq$1 GeV). Grilli, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 22 Dec 1971. 39p. Dep. NTIS (U. S. Sales Only).

Lectures are given on hadron production in $e^+ + e^-$ interactions at 1 to 2.4 GeV in colliding beams. Generalities on experimental techniques, pion form factors in the reaction $e^+ + e^- \to \pi^+ + \pi^-$ interactions, the cross sections for $e^+ + e^- \to \bar{p} + p$ interactions, and multiple hadronic production are reported. (J.F.P.)

32009 (LNF–72/5) NEUTRAL PION PHOTOPRODUCTION ON PROTON FROM DEUTERIUM IN THE ENERGY RANGE 400 TO 800 MeV. Bacci, C.; Baldini-Celio, R.; Esposito, B.; Mencuccini, C.; Reale, A.; Sciacca, G.; Spinetti, M.; Zallo, A. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 19 Jan 1972. 6p. Dep. NTIS (U. S. Sales Only).

A test is made of the validity of the impulse approximation from a comparison of the differential cross sections for photoproduction of π^0 on protons from hydrogen and deuterium. The incident photon energy was 400 to 800 MeV. (J.F.P.)

32010 (LNF–72/15) ANGULAR DISTRIBUTIONS FOR SINGLE NEUTRAL PION PHOTOPRODUCTION FROM NEUTRON AT 450 TO 800 MeV. Bacci, C.; Baldini-Celio, R.; Esposito, B.; Mencuccini, C.; Reale, A.; Sciacca, G.; Spinetti, M.; Zallo, A. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 17 Feb 1972. 10p. Dep. NTIS (U. S. Sales Only).

Differential cross sections for the photoproduction of single neutral pions from neutrons in deuterium at 450 to 800 MeV in the energy region between Δ(1236) and N(1518) were measured. The results seem to favor an appreciable presence of N(1417) in the neutron photoexcitation. (J.F.P.)

32011 (UCSB–34-P-135-17) HIGH ENERGY USER GROUP AT SANTA BARBARA. Progress Report for the Period May 1971–March 1972. Caldwell, David O. (California Univ., Santa Barbara). 1972. Contract AT(11-1)-Gen-10. 21p. Dep. NTIS.

A summary of experimental research on the existence of a short-range electromagnetic interaction, inclusive photon yields from high-energy bremsstrahlung, interaction of short-lived particles with nucleons, inelastic Compton scattering, total photoabsorption cross section measurements at NAL, and inclusive π^0 electroproduction in the deep inelastic region is given. A list of publications is included. (J.F.P.)

32012 SPATIAL DISTRIBUTIONS OF PHOTONEUTRONS IN THE 200-MeV ELECTRON-INDUCED CASCADE SHOWER. Ekusa, T. (Tohoku Univ., Sendai); Yano, T.; Yamazaki, N.; Watanabe, N.; Oyamada, M. Kakuriken Kenkyu Hokoku; 4: No. 1, 61-8(Sep 1971).

Preliminary measurements of the spatial distribution of the photoneutron yield in the electron-photon cascades in lead by 200-MeV electrons were carried out to offer some fundamental data on the design of the linac-booster system. These data are compared with the results of the energy loss measured by Murata. (auth) (Japan)

32013 ELECTROMAGNETIC FORM FACTORS OF THE NEUTRON AT SQUARED FOUR-MOMENTUM TRANSFERS OF 1.0 AND 1.5 $(GeV/c)^2$. Bartel, W. (DESY, Hamburg); Buesser, F.-W.; Dix, W.-R.; (and others). Phys. Lett.; 39B: No. 3, 407-10(1 May 1972).

Quasielastic electron–deuteron cross sections were measured at squared four-momentum transfers of 1.00 and 1.53 $(GeV/c)^2$ and electron-scattering angles at 12° and 86°. Both electron–neutron and electron–proton coincidences were recorded and the electromagnetic neutron form factors G_E^N and G_M^N were determined by the ratio method. The elastic e-p-scattering cross section derived from the quasielastic scattering cross sections agrees with the known cross section for electron scattering on a free proton. (auth)

32014 π^0 PHOTOPRODUCTION FROM COMPLEX NUCLEI. Meyer, W. T. (Cornell Univ., Ithaca, N. Y.); Browman, A.; Hanson, K.; (and others). Phys. Rev. Lett.; 28: No. 20, 1344-7(15 May 1972).

The photoproduction yields of π^0 mesons from D_2, Be, C, Al, Cu, Ag, and Pb targets have been measured at peak bremsstrahlung energies of 4.25, 5.6, 7.8, and 9.6 GeV. The A dependence of π^0 photoproduction is found to be almost independent of energy in this range in contrast to vector-meson dominance predictions. (auth)

32015 OBSERVATION OF A BROAD PEAK IN THE PRODUCTION OF FOUR CHARGED PIONS BY e^+e^- COLLISIONS AROUND 1.6 GeV. Barbarino, G. (CNEN, Frascati, Italy); Grilli, M.; Iarocci, E.; (and others). Lett. Nuovo Cim.; 3: No. 17, 689-92(22 Apr 1972).

The results of measurements and analysis of $e^+e^- \to \pi^+\pi^-\pi^+\pi^-$ interactions at a total energy of 1.2 to 2.4 GeV are presented. It is shown that the cross section as a function of total energy of the colliding beams has a behavior which can be taken as preliminary evidence for the existence of a ρ' meson of mass ~1600 MeV. (L.B.S.)

Weak

32016 (FRNC-TH–155) STUDY OF THE K^+ FORM FACTORS IN THE $K^+ \to \pi^+\nu$ DECAY. Kluberg, Louis (Paris Univ., Orsay (France)). 1971. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

In the framework of an investigation involving a large number of results on the K^+ form factors, form factors were determined from the Dalitz diagram of the $K^+ \to \pi^0 e^+ \nu$ mode. The method of analysis developed to resolve the difficulties due to inaccuracies in the measurements is given. The handling of the data involves selection of events, study and elimination of parasitic events, correct evaluation of the quantities measured and their associated errors; a summary of the Monte Carlo program is given. In the analysis of the results, the variation of the f_+ form factor with respect to the momentum transfer q^2 is assumed to be of the $f_+ q^2 = f_+(0)\ (1 + \lambda_+ + q^2/\mu^2)$ form. The data are first analyzed with the assumption that scalar and tensor terms, in addition to the vector term, are present in the matrix elements, and then analyzed assuming the presence of a single vector coupling. The results obtained for 1971 events using these two assumptions are $\lambda_+ = 0.018 \pm 0.015$ and $\lambda_+ = 0.023 \pm 0.013$ respectively. (France)

32017 (INR–1349) PROGRAMME FOR SELECTION OF CERTAIN HYPERNUCLEUS DECAYS. Kielczewska, Danuta; Tymieniecka, Teresa; Gajewski, Wojciech (Institute of Nuclear Research, Warsaw (Poland)). 1971. 40p. Dep. NTIS (U. S. Sales Only).

A method is proposed for the selection of some interesting events from the total sample of mesonic hypernuclei collected in the scanning of nuclear emulsion. This method based on the known values of the binding energy of hypernuclei does not require the measurement of pion energy. The criteria of the selection have been formulated and checked on a large sample of previously identified hypernuclei decaying via π^- emission. It is shown that the method permits the selection of kinematically unbiased sample of mesonic hypernuclei. (auth)

32018 (LA-tr–72-7) DEPOLARIZATION OF NEGATIVE MUONS IN SOLID SUBSTANCES. Dzhuraev, A. A.; Evseev, V. S.; Myasishcheva, G. G.; Obukhov, Yu. V.; Roganov, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from report JINR–P1–6020. 23p. Dep. NTIS.

The residual polarization of muons in solid substances is measured, and results are compared with the theory of cascade depolarization and examined for electron shell effects. The depolarization in oxygen compounds was also measured for an estimate of the interaction with adjacent atoms in residual polarization in a mesic atom of oxygen. (J.F.P.)

32019 HEAVY LEPTON QUESTION. Gershtein, S. S.; Landsberg, L. G.; Folomeshkin, V. N. (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 15: No. 2, 345-50 (Feb 1972). (In Russian).

Some experimental consequences of the possible existence of high-spin heavy leptons are considered. Possibilities for the observations of such leptons in proton accelerator experiments are discussed. A possibility is noted of using the high spin heavy lepton hypothesis to explain the isotropic cosmic muon background. (auth)

32020 OBSERVATION OF THE DECAY $K^+ \rightarrow \pi^0\pi^0e^+\nu$. Cline, D.; Ljung, D. (Univ. of Wisconsin, Madison). Phys. Rev. Lett.; 28: No. 19, 1287-90(8 May 1972).

Two decays analyzed as examples of the decay $K^+ \rightarrow \pi^0\pi^0e^+\nu$ were observed in a heavy-liquid bubble chamber. All four converted γ's are seen. A branching ratio of $1.8 + 2.4\ (-0.6) \times 10^{-5}$ is reported for this decay. The form factor f_1 for the decay is reported as $|f_1| = 0.97 + 0.50\ (-0.19)$. These results are in good agreement with $\Delta I = 1/2$ predictions. (auth)

Strong (Baryon-induced)

Refer also to abstracts 32309 and 32311.

32021 (ANL/HEP–7034, pp 97-116) SUGGESTIONS FOR NEW POLARIZATION EXPERIMENTS AT HIGH ENERGY. Berger, E. L.; Fox, G. C. (Argonne National Lab., Ill.). Apr 1970.

From Symposium on polarization at high energy; Argonne, Ill. (15 Apr 1970).

It is pointed out that polarization data supply important information concerning both the relative phase and spin-flip/spin-nonflip structure of scattering amplitudes. Model-dependent and model-independent considerations for choosing specific high-energy polarization experiments are discussed. Polarization studies in forward angles elastic scattering and exchange processes are discussed in some detail. (L.B.S.)

32022 (BNL–16674) NEGATIVE SEARCH FOR THE RADIATIVE DECAY $Y_1^*(1327) \rightarrow \Lambda^0\gamma$. Bassano, D.; Chu, R.; London, G. W.; (and others) (Brookhaven National Lab., Upton, N. Y.). 22 Jun 1971. 7p. (CONF-710609–14). Dep. NTIS.

From International conference on elementary particles; Amsterdam, Netherlands (30 Jun 1971).

An enhancement in the $\Lambda^0\gamma$ invariant mass attributed to a Y_1^* (1327) state produced with a (53 ± 15) μb cross section (~30% of the Σ^0 cross section) in 5-GeV/c π^- propane interactions has been reported in a heavy liquid bubble chamber experiment. No such effect was found in a similar experiment, using 2.1 GeV/c K^-. The results of a search for this state using the reaction $K^-p \rightarrow \Lambda^0\pi^0\gamma^0$ where all 3 γ's are seen and kinematic fitting is used to reduce the background and improve the resolution are reported. (auth)

32023 (INR-1350) OBSERVATION OF γ-RAYS FROM THE EXCITED STATES OF HYPERNUCLEI. Piekarz, Henryk (Institute of Nuclear Research, Warsaw (Poland)). 1971. 14p. (CONF-710911-13). Dep. NTIS (U. S. Sales Only).

From 4th international conference on high energy physics and nuclear structure; Dubna, USSR (7 Sep 1971).

The γ-transitions from the excited states of mass number 4 hypernuclei were observed in an experiment in which the K^--mesons were stopped in ^{6}Li and ^{7}Li targets. (auth)

32024 (JEN–227-IFIC/I-5) STUDY OF NUCLEAR FRAGMENTATION PRODUCED BY 19-GeV/c PROTONS. Melia Miralles, J. (Junta de Energia Nuclear, Madrid (Spain)). 1972. 19p. (In Spanish). Dep. NTIS (U. S. Sales Only).

The most important technical aspects of a new experimental method projected for the study of the p-nucleus interactions are exposed. The energy distributions of the protons, deuterons, tritium, helium-3 and alpha particles produced in the p-Al interactions at 19.8 GeV/c are shown. The results are compared with the predictions of the evaporation model. (auth)

32025 SEARCH FOR HEAVY PARTICLE IN HADRONIC INTERACTIONS. Anoshin, A. I.; Bashindzhagyan, G. L.; Bel'zer, L. I.; (and others) (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.); 15: No. 1, 6-8(5 Jan 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 1, 10-13(5 Jan 1972).

A search was made for production of a heavy unstable particle in cosmic hadron reactions with iron above 100 GeV in an ionization calorimeter at 3260 m above sea level. The production cross sections and lifetime for this particle are estimated. (J.F.P.)

32026 ONE- AND TWO-CENTER PROCESSES IN ENELASTIC INTERACTIONS AT ENERGIES ABOVE 100 GeV. Roinishvili, N. N. N.; Tatalashvili, N. G. (Inst. of Physics, Tbilisi, USSR). JETP Lett. (USSR) (Engl. Transl.); 15: No. 1, 1-3(5 Jan 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 1, 3-6(5 Jan 1972).

The fireball model was used to process the nuclear reactions of cosmic particles with average energy of 400 GeV with a polyethylene target. The various parameters of the showers, classified as one- or two-center events, are found. (J.F.P.)

32027 INVESTIGATION OF NUCLEAR INTERACTIONS OF COSMIC RAY MUONS UNDERGROUND. Bezrukov, L. B.; Beresnev, V. I.; Zatsepin, G. T.; (and others) (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 15: No. 2, 313-25(Feb 1972). (In Russian).

An apparatus consisting of three layers of scintillation counters was placed in a salt mine at a depth of 316 m.w.e. underground. The middle layer detected neutrons. Sizes of showers traversing the apparatus were measured. The number of neutrons accompanying the showers was detected. One could separate the nuclear showers from electromagnetic ones due to the existence of neutrons in the nuclear showers. The observed nuclear showers spectrum agrees with the spectrum calculated with the Hand expression if the photonuclear cross sections is $\sigma_{\gamma N} = (1.1 \pm 0.2) \cdot 10^{-28}$ cm^2/nucleon and $\sigma_{\gamma A} = A\sigma_{\gamma N}$ in the energy range from $2(10)^{10}$ to $2(10)^{11}$ eV. The specific photonuclear muon energy losses calculated with the experimental data is $b_n = (-dE_\mu/dx)_n/E_\mu = (0.57 \pm 0.11) \times 10^{-6}\ g^{-1} \cdot cm^2$. (auth)

32028 STUDY OF THE DECAY $\Lambda(1520) \rightarrow \Sigma(1385)\pi$. Mast, T. S.; Alston-Garnjost, M.; Bangerter, R. O.; (and others) (Univ. of California, Berkeley). Phys. Rev. Lett.; 28: No. 18, 1220–4 (1 May 1972).

The decay $\Lambda(1520) \rightarrow \Sigma(1385)\pi$ was studied in an energy-independent partial-wave analysis of the reaction $K^-p \rightarrow \Lambda\pi^+\pi^-$ in the momentum range 300 to 470 MeV/c. The width is found to be $\Gamma = 1.40 \pm 0.26$ MeV. Combining this result with one recently reported for $\Lambda(1690)$, one obtains a singlet-octet mixing angle $|\theta| = 73° \pm 10°$, in disagreement with the value $\theta = -25° \pm 6°$ derived from the two-body decays of the $J^P = 3/2^-$ states. (auth)

32029 ANALYSIS OF $p + d \rightarrow {}^3He + X^0$ EXPERIMENTS. Brody, H. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett.; 28: No. 18, 1217-20(1 May 1972).

Analysis of π^0, η^0, and ω^0 production by 2- and 3-GeV protons in the reaction $p + d \rightarrow {}^3He + X^0$ leads to an understanding of the variation of these cross sections with respect to momentum transfer and yields information concerning the ^{3}He form factor. It is shown that the observed missing-mass spectra at the 2π threshold, which deviates from phase space in this reaction (the ABC effect), can be explained using this momentum-transfer dependence of the ^{3}He form factor. (auth)

32030 MISSING-MASS SPECTRA PRODUCED BY 2-GeV PROTONS IN THE REACTION $p + d \rightarrow {}^3He + X^0$. Brody, H. (Univ. of Pennsylvania, Philadelphia); Groves, E.; Van Berg, R.; (and others). Phys. Rev. Lett.; 28: No. 18, 1215-17(1 May 1972).

The missing-mass spectra at the 2π threshold in the reaction $p + d \rightarrow {}^3He + X^0$ is investigated, and a search is made for the resonance reported at a mass of 450 MeV using 2-GeV protons. The shape of the missing-mass spectra below the η^0 mass deviates from two-body phase space and was similar to that obtained with 3-GeV protons. If a 450-MeV resonance exists, the c.m. cross section for producing it in this reaction is less than 10.8×10^{-36} and 5.7×10^{-36} cm^2/sr with 2- and 3-GeV protons, respectively. (auth)

32031 GENERAL CHARACTERISTICS OF PROTON–NUCLEON INTERACTIONS IN NUCLEAR EMULSION AT 67 GeV/c. Antonova, M. G. (High Energy Physics Inst., Alma-Ata, USSR); Boos, E. G.; Morozova, P. W.; (and others). Phys. Lett.; 39B: No. 2, 282-4(17 Apr 1972).

Interactions of 67 GeV/c protons with nucleons were studied in nuclear emulsion. Average proton-proton multiplicity is 6.63 ± 0.16. Strong anisotropy of the angular distribution is seen. (auth)

32032 COHERENT PRODUCTION OF PARTICLES BY 67 GeV/c PROTONS ON EMULSION NUCLEI. Antonova, M. G. (High Energy Physics Inst., Alma-Ata, USSR); Boos, E. G.; Morozova, P. W.; (and others). Phys. Lett.; 39B: No. 2, 285-8(17 Apr 1972).

Coherent reactions were observed among one-, three- and maybe five-prong interactions of 67 GeV/c protons in nuclear emulsion. Their cross sections were estimated and compared with other data on coherent production in emulsion. (auth)

32033 EXPERIMENTAL OBSERVATION OF THE ANGULAR DISTRIBUTION OF CHARGED PARTICLES AROUND 90^0 IN THE CENTER OF MASS PRODUCED BY PROTON–PROTON COLLISIONS AT VERY HIGH ENERGIES. Barbiellini, G.; Bozzo, M.; Darriulat, P.; (and others) (Technische Hochschule, Aachen. CERN, Geneva. Harvard Univ., Cambridge, Mass. INFN, Genoa. INFN, Turin). Phys. Lett.; 39B: No. 2, 294-8(17 Apr 1972).

The angular distribution of charged particles emitted between 47° and 90° in the center of mass was measured at the CERN Intersecting Storage Rings with a hodoscope of scintillation counters and for center-of-mass energies $E_{cm} = 30.2$, 44.7 and 52.7 GeV. Data are compatible with distributions of the type $1/\sigma_{inel} \times d\sigma/d\Omega\, (\theta_{cm}) = A(E_{cm}) \sin^{-2} \theta_{cm}$. The values of $A(E_{cm})$ are about a factor of two greater than the predictions of scaling from data at $E_{cm} = 6.0$ GeV. The shape of the angular distribution provides evidence for a flat distribution in the "rapidity" variable $y = \text{artanh}\,(p_L/E)$. (auth)

32034 PIONIZATION IN pp INTERACTIONS AT 12 AND 24 GeV/c. Mueck, H. J. (Univ., Bonn); Schachter, M.; Selonke, F.; (and others). Phys. Lett.; 39B: No. 2, 303-6(17 Apr 1972).

Inclusive π^- and π^+ distributions in the region of small longitudinal c.m. momenta, from pp interactions at 12 and 24 GeV/c, are presented and compared with CERN-ISR data. Interesting scaling and factorization properties are found. The extent to which the observed behavior can be interpreted as evidence for pionization is discussed. (auth)

32035 NEGATIVE HYPERON PRODUCTION AT HIGH ENERGY. Badier, J.; Bland, R.; Chollet, J. C.; (and others) (Ecole Polytechnique, Orsay, France. CERN, Geneva). Phys. Lett.; 39B: No. 3, 414-18(1 May 1972).

With a negative hyperon beam which was constructed at the CERN PS the production by 24 GeV/c proton of K^-, $\bar{p}$, Σ^-, and Ξ^-, with respect to π^- production, was measured. Measurements were made on a tungsten target under the following conditions: at a fixed angle of 10 mrad for momenta between 13 and 20 GeV/c, and at a fixed momentum of 17.2 GeV/c for angles between 10 and 40 mrad. Production was studied on three targets (B_4C, Al, W) at 17.2 GeV/c and 10 mrad. Photographs of hyperon decays were also taken in a prototype streamer chamber. (auth)

32036 SMALL ANGLE PROTON–PROTON ELASTIC SCATTERING FROM 9 TO 70 GeV/c. Beznogikh, G. G.; Buyak, A.; Kirillova, L. F.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 39B: No. 3, 411-13(1 May 1972).

Proton–proton elastic scattering was measured over the four-momentum transfer squared $0.0007 \le |t| \le 0.02$ GeV^2/c^2. A gas hydrogen jet was used as an internal target of the accelerator. The results indicate that the ratio of the real to the imaginary part of the proton–proton forward scattering amplitude rises smoothly with increasing energy from $\alpha = -0.35 \pm 0.05$ at $p = 9.39$ GeV/c to $\alpha = -0.092 \pm 0.011$ at $p = 69.8$ GeV/c. (auth)

Strong (Meson-induced)

Refer also to abstract 32308.

32037 (ANL/HEP-7034, pp 46-72) RECENT EXPERIMENTAL RESULTS ON HIGH ENERGY POLARIZATIONS. Reibel, K. (Ohio State Univ., Columbus. Dept. of Physics). Apr 1970.

From Symposium on polarization at high energy; Argonne, Ill. (15 Apr 1970).

Recent results on polarization measurements in πp, Kp, pp, and $\bar{p}$p interactions at 6, 10, and 17.5 GeV/c are presented and discussed. (L.B.S.)

32038 (ANL/HEP-7034, pp 117-46) RECENT INTERMEDIATE ENERGY EXPERIMENTS ON K^+p AND π^+p POLARIZATION. Koehler, P. F. M. (Argonne National Lab., Ill.). Apr 1970.

From Symposium on polarization at high energy; Argonne, Ill. (15 Apr 1970).

Some recent data on K^+p and π^+p polarization obtained at CERN, BNL, and ANL are presented. Some of the experimental methods used for these measurements are briefly discussed. The K^+p polarization data are discussed in terms of phase shift analysis and compared with Regge model calculations. The extent to which various existing Regge models are able to predict the polarization in π^+p scattering, particularly in the backward direction, is shown. (L.B.S.)

32039 (BNL-16681) HIGH ENERGY DIFFERENTIAL CROSS SECTIONS FOR K^0 PRODUCTION. Willen, E. H.; Foley, K. J.; Kramer, M. A.; Love, W. A.; Ozaki, S.; Platner, E. D.; Saulys, A. C. (Brookhaven National Lab., Upton, N. Y.); Lindenbaum, S. J. (Brookhaven National Lab., Upton, N. Y. City Coll., New York). [1972]. 75p. (CONF-720419-1). Dep. NTIS.

From fourth international conference on high energy collisions; Oxford, England (5 Apr 1972).

Differential and total cross sections are studied for the reactions $\pi^- + p \rightarrow K^0 + \Lambda(\Sigma^0)$ at 8 to 15.7 GeV/c, $K^- + p \rightarrow \overline{K}^0 + n$ at 10.7 and 15.7 GeV/c, and $K^+ + p \rightarrow K^0 + N^{*++}$ at 15.7 GeV/c using the double vee magnetic spectrometer. (J.F.P.)

32040 (COO-1195-235) STUDY OF THE DIFFERENTIAL CROSS SECTION OF THE REACTION PI-MINUS PROTON GOES TO OMEGA-ZERO NEUTRON AT 3.65, 4.5, AND 5.5 GeV/c. Russell, Allison Dean (Illinois Univ., Urbana). 1971. Contract AT(11-1)-1195. 108p. Dep. NTIS.

Thesis.

A scintillation counter and optical spark chamber experiment was performed to study the differential cross section for the reaction $\pi^-p \rightarrow \omega^0n$ at 3.65, 4.5 and 5.5 GeV/c. The data show a substantial unnatural parity contribution to the scattering amplitude. The natural parity part of the cross section is not consistent with the predictions of a simple model using Reggeized ρ exchange. (auth)

32041 (ITEF-859) STUDY OF THE REACTION $\pi^- + p \rightarrow n + \pi^+ + \pi^-$ AT INCIDENT MOMENTUM OF 40 GeV/c. (Statement of the Experiment). Barkov, B. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1971. 16p. (In Russian). Dep. NTIS (U.S. Sales Only).

The dependence of the differential cross section on the transmitted four-momenta was measured for the reaction $\pi^- + p \rightarrow n + \pi^+ + \pi^-$ during an initial momentum of a π^--meson. The neutrons generated were recorded by a hodoscopic system, consisting of eight scintillation counters, and a spectrometer analyzed the $\pi^\pm$-mesons. Cross section values were tabulated for various values of P_l (in GeV/c). (K.S.W.)

32042 $\pi^-p \rightarrow \pi^-\pi^+n$ REACTION AT $p\pi^- = 4.45$ GeV/c. Kartamyshev, A. A.; Mukhin, K. N.; Romantseva, A. S.; Sulkovskaya, M. M.; Sustavov, A. F. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 15: No. 2, 294-9(Feb 1972). (In Russian).

The cross sections σ_{tot} and $d\sigma/dt$ for a $\pi^-p \rightarrow \pi^-\pi^+n$ reaction at 4.45 GeV/c and for ρ^0- and f^0-resonances being produced in this reaction is measured with a bubble chamber method. The results are: $\sigma_{tot} = 2.8 \pm 0.3$ mb, $\sigma_{\rho^0} = 0.84 \pm 0.08$ mb, $\sigma(f^0 \rightarrow \pi^+\pi^- = 0.47 \pm 0.05$ mb. The elastic $\pi^-\pi^+$-scattering cross section in the interval $0.28 \le \omega_{\pi\pi} \le 1.5$ GeV is calculated by the Chew–Low extrapolation and in the pseudoperipheric approximation. The values $\sigma^{el}_{\pi\pi}(\rho^0) = 100 \pm 25$ mb, $\sigma^{el}_{\pi\pi}(f^0 \rightarrow \pi^+\pi^-) = 25 \pm 9$ mb are obtained in the ρ^0- and f^0-resonance regions. (auth)

32043 INVESTIGATION OF $\pi^- + p \rightarrow n + m\gamma$ $(m \ge 3)$ REACTIONS AT THE MOMENTUM 2.94 GeV/c. Barmin, V. V.; Golubchikov, V. M.; Davidenko, G. V., (and others) (Inst. of

Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 15: No. 2, 288-92(Feb 1972). (In Russian).

Systems of π^0-mesons and γ-quanta were investigated in $\pi^- + p \rightarrow n + m\gamma$ reactions at π^--meson momentum 2.94 GeV/c. Maxima are observed in the effective mass distributions of $\pi^0\gamma$- and $2\pi^0$-systems, corresponding to ω- and f-mesons productions. A large enhancement over the phase curve of the $2\pi^0$-system is observed at a mass ~700 MeV and width ~350 MeV. The values of the spin density matrix elements ρ_{00}, $\rho_{1,-1}$ and Re ρ_{10} are obtained, from the $\omega \rightarrow \pi^0 + \gamma$ decay. Four momentum squared and angular distributions are obtained for the different regions of the $\pi^0\gamma$- and $2\pi^0$-systems. Cross sections of $\pi^- + p \rightarrow n + m\gamma$ reactions at m = 3, 4, 6, 8, 10 and of some other reactions with π^0-mesons and γ-quanta production are given. (auth)

32044 MESON MASS SPECTRUM NEAR THE $X^0(958)$. Binnie, D. M. (Imperial Coll. of Science and Tech., London); Camilleri, L.; Duane, A.; (and others). Phys. Lett.; 39B: No. 2, 275-8(17 Apr 1972).

The meson mass spectrum near the $X^0(958)$ was studied in the reaction $\pi^- + p \rightarrow$ missing mass + n near threshold. A single peak, consistent with the X^0 is seen. The mass obtained is 957.1 ± 0.45 MeV and the width is less than 1.9 MeV(95% C. L.). (auth)

32045 POLARIZATION IN THE REACTION $\pi^+p \rightarrow K^+ \Sigma^+$ AT 1.11 GeV/c. Bellamy, E. H. (London Univ.); Anderson, J.; Crawford, J. F.; (and others). Phys. Lett.; 39B: No. 2, 299-302 (17 Apr 1972).

The polarization of the recoil sigma in the reaction $\pi^+p \rightarrow K^+\Sigma^+$ was measured at 12 production angles at a beam momentum of 1.11 GeV/c using counters and spark chambers. The new data are compared with existing phase shift solutions to $\pi p \rightarrow K\Sigma$ channels in the low energy regions. (auth)

32046 STUDY OF THE REACTION $K^+p \rightarrow K^0\Delta^{++}(1236)$ AT 2.25 GeV/c. Neuhofer, G. (CERN, Geneva); Niebergall, F.; Regler, M.; (and others). Phys. Lett.; 39B: No. 2, 271-4(17 Apr 1972).

The reaction $K^+p \rightarrow K^0\Delta^{++}(1236)$ was studied at 2.25 GeV/c incident momentum. Results based on 15,800 events are discussed. The differential cross section is observed to be strongly suppressed at $t' = 0$. Spin density matrix elements show a dominance of helicity flip at $|t'| \neq 0$. (auth)

32047 SCALING IN THE SEMI-INCLUSIVE REACTIONS $K^+p \rightarrow K^0$ + n (CHARGED) + ANYTHING AT 5, 8.2, AND 16 GeV/c. Chliapnikov, P. V. (CERN, Geneva); Nielsen, S.; Ciapetti, G.; (and others). Phys. Lett.; 39B: No. 2, 279-81(17 Apr 1972).

The scaling properties of the semi-inclusive reactions $K^+p \rightarrow K^0$ + n(charged) + X^0(neutral) were studied, measuring the momentum spectra of K^0-mesons for a given number of prongs n. Distributions of the particle density $\omega(d\sigma_n/dp_L)\ \sigma_n$ for the inclusive K^0 at n = 2 and n = 4 show evidence for limited scaling at 5.0, 8.2 and 16 GeV/c incident K^+ momenta. (auth)

32048 ENERGY DEPENDENCE OF INCLUSIVE DISTRIBUTIONS IN PION-INDUCED REACTIONS. Alston-Garnjost, Margaret (Univ. of California, Berkeley); Barnham, K. W.; Rabin, M. S.; (and others). Phys. Lett.; 39B: No. 3, 402-6(1 May 1972).

Data are presented on the inclusive distributions $\pi^+p \rightarrow \pi^\pm$ + anything and $\pi^-p \rightarrow \pi^-$ + anything at momenta from 3.7 to 18.5 GeV/c. Distributions are presented in the laboratory, center-of-mass and projectile systems, and the approach to scaling is discussed. (auth)

32049 RESONANCE PRODUCTION IN FOUR BODY FINAL STATE OF K^+p INTERACTIONS AT 10 GeV/c. Huq, S. S. (Univ. of Raishahi, Pakistan). J. Natur. Sci. Math.; 11: No. 1, 7-12 (Apr 1971).

The reaction $K^+p \rightarrow K^+\pi^+\pi^-p$ was studied from a sample of 3,787 unique fitted four-body final states of the above reaction produced with a cross section of (0.96 ± 0.12) mb. The dominant feature of the reaction was strong production of K*(892) and some K*(1400) resonance either singly or simultaneously produced with N*(1236). K*(1400) is exclusively produced along with N*(1236) resonance and some ρ^0 meson production was also observed. In addition, there is strong evidence for Q-enhancement in the low $K\pi\pi$ mass region of 1.3 GeV/c^2, and K*(1800) in the high $K\pi\pi$ mass region was also observed. All these resonances are produced very peripherally as is evident from their sharply peaked forward and backward c.m. production angular distributions. (auth)

32050 SCALING PROPERTIES OF THE INCLUSIVE REACTION $K^- + p \rightarrow \Lambda$ + ANYTHING. Deutschmann, M. (Technische Hochschule, Aachen); Kirk, H.; Gensch, U.; (and others). Nucl. Phys.; B39: No. 1, 133-40(1972).

The scaling properties of the reaction $K^- + p \rightarrow \Lambda$ + anything are studied at 4.2 and 10.1 GeV/c. In this energy range, this reaction is peculiar, as it practically coincides with the hypercharge annihilation reaction $K^- + p \rightarrow \Lambda$ + pions and has a cross section rapidly decreasing with increasing energy. It is found that while the Feynman function $(E^*/\pi p^*_{max})d\sigma/dx$ and the function $d\sigma/dx$ do not scale in the energy range studied, the distributions at 4.2 and 10.1 GeV/c of the function $(1/\sigma(\Lambda)d\sigma/dx$ where $\sigma(\Lambda)$ is the cross section for Λ-production coincide over the entire x-range. Comments are made on the facts that this inclusive reaction is undeveloped and that the hypercharge annihilation reaction is neither inclusive nor exclusive. (auth)

32051 STRANGE-PARTICLE PRODUCTION IN π^-p COLLISIONS AT 11.2 GeV/c LEADING TO TWO CHARGED FINAL PARTICLES. Dameri, M. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa); Tomasini, G.; Trevisan, U.; (and others). Nuovo Cim.; 9A: No. 1, 1-27(1 May 1972).

The results of an analysis of strange-particle production in π^-p collisions leading to two charged final particles and at least one strange neutral decay are presented. The sample consists of some 2600 events detected in both the 1.5 m British National Hydrogen Bubble Chamber and the 2 m CERN Hydrogen Bubble Chamber exposed to a 11.2 GeV/c π^- beam at the CERN 28 GeV PS accelerator. Cross sections for the various possible final states are reported and compared with results obtained at other energies. Contributions of known resonances such as $N^*_{1688}(K^0\Lambda^0)$, $K^*_{890}(K\pi)$, $Y^*_{1385}(\Lambda^0\pi)$, $S^*(K_1^0K_1^0)$ and $A_2^-(K^-K^0)$ to the different production channels were evaluated. In particular comparison with data previously obtained on the same film establishes the branching ratios for A_2^- and S* decays. (auth)

Particle Interactions and Properties (Theoretical)

General

32052 (ANL/HEP-7034) TALKS PRESENTED AT THE SYMPOSIUM ON POLARIZATION AT HIGH ENERGY, 15 APRIL 1970. (Argonne National Lab., Ill.). 167p. (CONF-700455). Dep. NTIS.

Nine papers are included; a separate abstract was prepared for each paper. (L.B.S.)

For abstracts of individual papers see: 31668, 31692, 32004, 32021, 32037, 32038, 32163, 32164, and 32245.

32053 (LNF-72/9) SCATTERING OF n(>2) INCIDENT PARTICLES. Pancheri-Srivastava, G.; Srivastava, Y. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 10 Feb 1972. 6p. Dep. NTIS (U. S. Sales Only).

The general case of an arbitrary number of incident particle interactions is considered, and a simple formalism for transition rates is developed. The case of equal-energy and oppositely directed e^+ and e^- beams colliding with a proton target with observation of an N* resonance is also considered. Finally, the rate for $p + p + p \rightarrow$ anything is found. (J.F.P.)

32054 (RPP/C-34) SHAPES OF INCLUSIVE SINGLE PARTICLE SPECTRA IN THE FRAGMENTATION AND PIONISATION REGIONS. Ranft, Gisela (Leipzig Univ. (East Germany)). [1971]. 27p. Dep. NTIS (U. S. Sales Only).

The shapes of single particle spectra in the fragmentation and pionization regions are reviewed, and the present evidence for scaling behavior or limiting fragmentation are discussed using the multiperipheral and thermodynamic models. (J.F.P.)

32055 CONSTRUCTION OF MULTIPERIPHERAL DYNAMICAL EQUATIONS AND INCLUSIVE SUM RULES. Tan, Chung-I (Brown Univ., Providence). Phys. Rev., D; 5: No. 6, 1476-81 (15 Mar 1972).

Multiperipheral-like integral equations are derived from inclusive sum rules by making direct approximations on inclusive cross sections. As a result, the physical basis of multiperipheral dynamics is clarified. Furthermore, the Regge behavior for exclusive processes and the scaling property of inclusive cross sections can be considered as consequences of our dynamical approximations. (auth)

32056 LOCAL CURRENT-ALGEBRA SUM RULES IN THE REST FRAME. Chanowitz, Michael S. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 5: No. 6, 1444-63(15 Mar 1972).

Finite-moment sum rules in the rest frame are considered. We show (a) that the usual derivations are incorrect for kinematical reasons, and (b) that the disconnected contributions are large. The largeness of the disconnected contributions is an advantage since they alone can be measured. Three pion sum rules are derived, one of which implies the first spectral-function sum rule in the chiral limit; the derivation leads naturally to a proposal to test the spectral-function sum rule experimentally. Five nucleon sum rules are also derived from which the I = 1 charge radius of the nucleon and the slopes at threshold for $\sigma(e^+e^- \rightarrow N\bar{N})_{I=1}$ and $\sigma(e^+e^- \rightarrow N\bar{\Delta})_{I=1}$ are calculated. (auth)

32057 FINITE-ENERGY SUM RULES FOR INCLUSIVE PROCESSES. Kwiecinski, J. (Inst. of Nuclear Physics, Krakow). Lett. Nuovo Cim.; 3: No. 15, 619-22(8 Apr 1972).

The formalism of finite-energy sum rules for inclusive processes is developed. More precisely the finite-energy sum rules for that part of the inclusive cross sections which may be related to the Reggeon-particle amplitudes is discussed. (L.B.S.)

32058 GENERALIZED LORENTZ TRANSFORMATION AND ITS IMPLICATIONS FOR OBSERVABILITY OF TACHYONS. Naranan, S. (Tata Inst. of Fundamental Research, Bombay). Lett. Nuovo Cim.; 3: No. 15, 623-6(8 Apr 1972).

It is shown that if the generalization of the Lorentz transformation given by Gilson is physically meaningful, then it implies that no particles of velocity exceeding c are observable in any inertial frame, and that none of the properties discussed are measurable in any experiment. (L.B.S.)

32059 CONSTRUCTION OF AN ELEMENTARY PARTICLE THEORY IN COSMOLOGICAL SPACE. Kurdgelaidze, D. F.; Plyusnin, L. N. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 10, 79-83(1971). (In Russian).

A four-dimensional space distortion is embedded in a six-dimensional plane space by the method of insertion, wherein the former occupies a surface. On the basis of the symmetry of the indicated surface a scalar field equation is written on this surface. Using the insertion method, the equation obtained is transformed to the original distorted four-dimensional space. The well-known equation for a scalar field which has been obtained by other authors, is a special case of the equation obtained here. (tr-auth)

32060 INCLUSIVE REACTIONS: A SURVEY. Young, J. E. (Massachusetts Inst. of Tech., Cambridge). Contract AT(11-1)-3068. Riv. Nuovo Cim.; 2: No. 1, 88-129(Jan-Mar 1972).

The basic set of kinematic features for inclusive reactions involving one and two particles is discussed. The distributions in inclusive processes and the integral equation describing these distributions are then discussed. Direct-channel expansions are presented for one-particle and two-particle processes. A conclusion and summary are given together with some indications of future lines of investigation. (L.B.S.)

Electromagnetic

Refer also to abstracts 32222 and 32264.

32061 (DESY-72/5) ELECTROPRODUCTION EXPERIMENTS IN HIGH ENERGY PHYSICS. Heinloth, K. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Feb 1972. 97p. (In German). Dep. NTIS (U. S. Sales Only).

Available experimental information about inelastic electron scattering and about the discreet electroproduction of mesons are compiled and discussed. Based on this information, both model concepts of nucleon structure and photon-hadron coupling are discussed. From a comparison of experimental predictions resulting from the two types of processes, model concepts are refined and limitations of such models are outlined. (tr-auth)

32062 (KHFTI-70-40) PROGRAM FOR CALCULATING CONSERVATION LAWS IN A CHAMBER EXPERIMENT. Zinov'eva, O. G.; Zolenko, V. A.; Koltunov, I. A. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

A program is proposed for calculating conservation laws for photoproduction reactions in a chamber. The improved method for the refinement of track parameters effects economy in machine time in comparison with other identification programs. Knowing the parameters of the charged particles the presence of a neutral particle may be established, and thence its initial momentum and the energy of the incident photon. If a neutral particle is not present, then the parameters of the visible particles may be rectified so as to comply with the laws of conservation of energy and momentum, and subsequently to determine the energy of the incoming γ quantum. (K.S.W.)

32063 (LNF-72/17) HADRONIC CONTRIBUTIONS TO THE MUON ANOMALOUS MAGNETIC MOMENT. Bramon, A.; Etim, E.; Greco, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 23 Feb 1972. 9p. Dep. NTIS (U. S. Sales Only).

The hadronic contribution to the muon anomalous magnetic moment is calculated using recent results from colliding beam experiments; a value of $(68 \pm 9) \times 10^{-9}$ is obtained. (auth)

32064 (NP-19285) IMPLICATIONS OF GAUGE-INVARIANCE FOR PION ELECTROPRODUCTION AT THRESHOLD. Note No. 354. Benfatto, G.; Nicolo, F.; Rossi, G. C. (Rome Univ. (Italy). Istituto di Fisica). 15 Jan 1972. 28p. Dep. NTIS (U. S. Sales Only).

The implications of gauge invariance in the problem of the on-shell extrapolation of the electroproduction low-energy theorems are discussed. It is shown that there is an invariant amplitude which can be evaluated at the Breit threshold either using gauge-invariance and on-shell dispersion relations or following the Fubini and Furlan (Ann. Phys. (N.Y.) 48, 322 (1968)) extrapolation method starting from the current algebra low-energy value of the amplitude. Comparing the two expressions, a relation between the electromagnetic pion form factor, $F_\pi(K^2)$, and the axial-vector nucleon form factors $g_A(K^2)$ and $h_A(K^2)$ is found. (auth)

32065 (RLO-1388-624) INELASTIC e^-p STRUCTURE FUNCTIONS IN A GLUON MODEL. Blaha, Stephen (Washington Univ. Seattle. Dept. of Physics). [1971]. 7p. Dep. NTIS.

Comments are made on apparent disagreements in calculations of the inelastic e^-p structure functions in the neutral vector gluon model (also known as massive QED). (auth)

32066 INELASTIC HADRONIC PROCESSES AT LARGE MOMENTUM TRANSFERS AND DEEP INELASTIC ELECTROPRODUCTION. Matinyan, S. G.; Ter-Isaakyan, N. L.; Khoze, V. A. JETP Lett. (USSR) (Engl. Transl.); 15: No. 2, 76-8(20 Jan 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 2, 110-13(20 Jan 1972).

It is found that at high energies and large momentum transfers the electromagnetic mechanism of the production of hadrons has an important role in inelastic hadronic processes and may be dominating. Proton-proton interactions are studied. (J.F.P.)

32067 INTERACTION OF VIRTUAL PHOTONS WITH PRODUCTION OF A PAIR OF PIONS. Khleskov, V. I. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.); 15: No. 2, 85-8(20 Jan 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 2, 123-6(20 Jan 1972).

The reaction $\gamma + \gamma \rightarrow \pi^+\pi^-$ in $e^+ + e^-$ interactions in colliding beams is analyzed using dispersion relations for virtual space-like photons with specified squared four-momenta. The amplitudes and cross sections are discussed. (J.F.P.)

32068 CONTRIBUTION TO THE THEORY OF INSTABILITY OF CHARGED-PARTICLE BEAMS PASSING THROUGH AN INHOMOGENEOUS MEDIUM AND INSTABILITY OF NONUNIFORMLY MOVING BEAMS. Buts, V. A. JETP Lett. (USSR) (Engl. Transl.); 15: No. 1, 36-9(5 Jan 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 1, 52-6(5 Jan 1972).

It is shown that an exponential growth of the perturbations in an electron beam is produced when the conditions for Cherenkov radiation are not satisfied but the medium is inhomogeneous or the beam particles move with acceleration. An inhomogeneous unbounded beam passing with constant velocity and then acceleration through an inhomogeneous dielectric is considered. (J.F.P.)

32069 INCOHERENT PHOTOPRODUCTION OF VECTOR MESONS ON NUCLEI AT LARGE MOMENTUM TRANSFER. Gevorkyan, S. R.; Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 15: No. 2, 248-50(Feb 1972). (In Russian).

Expressions for the noncoherent V^0-meson photoproduction cross sections on nuclei are obtained. Unlike previous work it is correct at any momentum transfer within the limits of Glauber theory applicability. It is shown that the investigation of such processes at large momentum transfer can be used to obtain information on the slope parameter in the differential elastic cross section of V^0N-scattering. (auth)

32070 NATURE OF OPERATOR SCHWINGER TERMS, FIXED POLES, AND SCALE-INVARIANCE BREAKING AT SHORT DISTANCES. Bitar, Khalil M. (International Centre for Theoretical Physics, Trieste, Italy. American Univ., Beirut). Phys. Rev., D; 5: No. 6, 1498-1509(15 Mar 1972).

General arguments are given that if there are operator Schwinger terms in the equal-time commutator of the time and space components of the electromagnetic current these must be of both scalar and tensor nature. The contribution of the tensor term is isolated and shown to be proportional to $-(1/\pi) \int_0^\infty d\tilde{\omega}F_2(\omega)$. $\tilde{F}_2(\omega)$ is the Bjorken scale function less its leading scaling Regge parts. The existence of such a term is then related to the presence of a fixed pole at $j = 0$ in the real part of the amplitude νT_2. This seems to be substantiated by the data. From the point of view of light-cone (or short-distance) operator-product expansions, such a term is shown to lead to scale-invariance breaking. The specific term expressing this breaking is then given and is shown not to disturb scaling in the variable ω. (auth)

32071 PATHOLOGIES OF NONCANONICAL DIMENSIONS. Gatto, R. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua); Menotti, P. Phys. Rev., D; 5: No. 6, 1493-7(15 Mar 1972).

Noninteger-power and logarithmic light-cone singularities for forward matrix elements of current commutators are examined in connection with the scaling properties of the Compton amplitude in the Bjorken limit and with the asymptotic properties in the Regge limit. Properties of compact support for the scaling functions are lost for noninteger-power singularities, and fixed (simple or multiple) Regge poles occur with complex residues. The residues of the fixed Regge poles are related to integrals over the scaling functions. (auth)

32072 ρ-DOMINANCE ELECTROMAGNETIC PION FORM FACTOR WITH VACUUM-POLARIZATION INSERTIONS. Buchl, R. A.; Nigam, B. P. (Arizona State Univ., Tempe). Can. J. Phys.; 50: No. 2, 119-21(15 Jan 1972).

The ρ-meson propagator is modified by insertions of the vacuum-polarization tensor due to charged pion pairs. The sum of all such contributing graphs via the Duffin–Kemmer formalism is seen to give a Breit–Wigner-type expression for the electromagnetic pion form factor. The width of the ρ meson is associated with the absorptive part of the pion form factor, and at $t = m_\rho^2$ it is estimated $f_{\rho\pi\pi}^2/4\pi = 2.5$ using the experimental width $\Gamma_\rho = 125 \pm 20$ MeV. (auth)

32073 GAUGE INVARIANCE AND THE REACTIONS $2\gamma \rightarrow (2n + 1)\pi$. Bacry, H.; Nuyts, J. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 5: No. 6, 1539-41 (15 Mar 1972).

The conditions are given on the possible Lagrangian which are compatible with a chiral SU(2) $\otimes$ SU(2) symmetry broken by the electromagnetic field. Among some examples of such Lagrangians the most general one which dominates the $2\gamma \rightarrow (2n + 1)\pi$ reactions at the soft-pion limit is presented. Some consequences are compared with particular results obtained earlier by Aviv, Hari Dass, and Sawyer, and by Yao. (auth)

32074 GAUGE INVARIANCE, CHIRAL SYMMETRY, AND $\gamma + \gamma \rightarrow$ ODD NUMBERS OF SOFT PIONS. Dass, N. D. Hari (Univ. of California, Los Angeles). Phys. Rev., D; 5: No. 6, 1542-5(15 Mar 1972).

Using electromagnetic gauge invariance, chiral symmetry, and the requirement that an amplitude involving soft pions vanish when the neutral-pion four-momentum vanishes (or equivalently that the divergence of the axial-vector current in the symmetry limit be independent of pion fields), a unique expression is derived for the effective Lagrangian describing the interaction of photons with odd numbers of soft pions in arbitrary charge combinations. (auth)

32075 COMMENTS ON RELATIVISTIC MOTION WITH RADIATION REACTION. Sen Gupta, N. D. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., D; 5: No. 6, 1546-7(15 Mar 1972).

It is shown that, for the class of electromagnetic fields for which $\vec{E} \cdot \vec{H} = 0$ and $|\vec{E}|/|\vec{H}| = $ const, there is an exact integral of the Lorentz–Dirac equation of motion. For synchrotron motion this reduces to $d\vec{r}_{||}/dt = $ const; hence, the loss of kinetic energy of the particle is only due to the continuous decrease in magnitude of the transverse component of its velocity. (auth)

32076 INELASTIC e–p SCATTERING AND THE POLARIZATION CONTRIBUTION TO H HYPERFINE STRUCTURE. Jensen, D.; Kovesi-Domokos, S.; Schonberg, E. (Johns Hopkins Univ., Baltimore). Phys. Rev., D; 5: No. 6, 1397-1400(15 Mar 1972).

The structure functions obtained from a specific resonance model of inelastic e-p scattering are used to evaluate the polarizability correction to the ground-state hyperfine splitting of hydrogen. By requiring that the spin-flip amplitude for real Compton scattering satisfy the Drell–Hearn sum rule, the only free parameter in the model can be fixed. It is found that the polarizability corrections are approximately 1 ppM, in good agreement with the existing bounds on the uncertainty of quantum-electrodynamic calculations of hyperfine structure. (auth)

32077 COMPTON SCATTERING AND FIXED POLES IN PARTON FIELD-THEORETIC MODELS. Brodsky, Stanley J.; Close, Francis E.; Gunion, J. F. (Stanford Univ., Calif.). Phys. Rev., D; 5: No. 6, 1384-8(15 Mar 1972).

A class of parton models is extended to a fully gauge-invariant theory for the full Compton amplitude. The existence of local electromagnetic interactions is shown to always give rise to a constant real part in the high-energy behavior of the amplitude $T_1(\nu,q^2)$. In the language of Reggeization this is interpreted as a fixed pole at $J = 0$ in T_1 and νT_2, with residue polynomial in the photon mass squared. (auth)

32078 STATISTICS OF A COMPOSITE PHOTON FORMED OF TWO FERMIONS. Perkins, W. A. (Univ. of California, Berkeley). Phys. Rev., D; 5: No. 6, 1375-84(15 Mar 1972).

A modification of the author's earlier version of the neutrino theory of photons is presented. A composite-photon distribution is obtained which is similar enough to Planck's distribution to satisfy experimental results. Linearly polarized photon operators are constructed and the theory is shown to describe truly neutral photons, thus removing an objection that had been raised against the earlier version by Berezinskii. (auth)

32079 MASS SHIFT OF A CHARGED SCALAR PARTICLE IN AN INTENSE STANDING ELECTROMAGNETIC WAVE. Berkowitz, Harry L. (Army Electronics Command, Fort Monmouth, N. J.); Rosen, Bernard. Phys.Rev., D; 5: No. 6, 1308-12(15 Mar 1972).

A method for the approximate solution to the Klein–Gordon equation for a charged particle in the presence of two electromagnetic, noncollinear, transverse plane waves was developed. The solution is a product of functions which are either solutions to linear, ordinary, differential equations of the Hill type or solutions to a Volkov equation. The mass-energy relation for the scalar particle in this approximation has a complicated dependence on the field strengths and on the particle momentum. In particular, it is found that a slowly moving particle in an intense standing electromagnetic wave has a mass shift of order v^2/c^2 times that given by second-order perturbation theory. Here v is the component of particle velocity perpendicular to the direction of "propagation" of the waves. (auth)

32080 SYMMETRY RELATION FOR RADIATING PARTICLES IN ATTRACTIVE VERSUS REPULSIVE COULOMB FIELDS. Biedenharn, L. C. (Duke Univ., Durham, N. C.); Brussaard, P. J.; Sheth, C. V.; Swamy, N. V. V. J.; Cooper, J. Phys. Rev., D; 5: No. 6, 1288-96(15 Mar 1972).

It is demonstrated that the radiative properties of charged particles moving in an attractive Coulomb field are related by a remarkable symmetry property to those for a repulsive Coulomb field. This symmetry relation is discussed from the classical as well as the quantal point of view. The classical results allow a rather unusual interpretation in which the two branches of the hyperbola (attractive and repulsive fields) are united into a single closed integration contour. This interpretation is shown to agree with the classical limit of the complete result. (auth)

32081 DEEP-INELASTIC ELECTROPRODUCTION, SCALING, AND FORM FACTORS OF THE NUCLEON IN A BREMSSTRAHLUNG MODEL. Moreno, Hector (Stanford Univ., Calif.). Phys. Rev., D; 5: No. 6, 1417-22(15 Mar 1972).

It is shown how one can account for the main features of the nucleon's elastic and inelastic form factors and of the electroproduction experiments in the framework of a simple bremsstrahlung model. (auth)

32082 REGGE POLE ANALYSIS OF INELASTIC e–p SCATTERING DATA. Matsumoto, Y.; Muta, T.; Nakajima, H.; (and others) (Kyoto Univ.). Phys. Lett.; 39B: No. 2, 258-62(17 Apr 1972).

Based on the Regge pole fit to the high energy data on the e-p structure functions the q^2-dependence of the Pomeranchuk and A_2 residues is determined in the non-scaling region. A FESR for νW_2 together with knowledge of these Regge residues is employed to confirm the existence of the $J = 0$ fixed pole in the virtual Compton amplitude. (auth)

32083 ISOVECTOR FORM FACTORS AND THE RHO-PRIME. Shaw, G. (Daresbury Nuclear Physics Lab., Eng.). Phys. Lett.; 39B: No. 2, 255-7(17 Apr 1972).

A simple but successful pole model for the low q^2 behavior of the pion, $\Delta N\gamma$ and nucleon isovector form factors is given, using the Dirac form factors in the latter case. The rho-prime required decouples completely from charge form factors, so that its only two body decay mode is $\omega\pi$. (auth)

32084 ASYMPTOTIC BEHAVIOR OF THE COMPOSITE NUCLEON FORM FACTORS. Kirillov, A. I. (Mathematics Inst., Moscow); Shirokov, Yu. M.; Troitskii, V. E. Phys. Lett.; 39B: No. 2, 249-50(17 Apr 1972).

A new method is proposed for evaluating the nucleon electromagnetic form factors in terms of the p_{11} pion-nucleon phase shift. The asymptotic behavior of the form factors is discussed. (auth)

32085 DISPERSION RELATIONS AND DATA ON THE REACTIONS $\gamma \rightleftharpoons p\pi^-$ IN THE Δ(1236) RESONANCE REGION. Aznauryan,

I. G.; Zaslavskii, A. N. (Erevan Physical Inst.). Phys. Lett.; 39B: No. 2, 226-8(17 Apr 1972).

It is shown that there is a discrepancy in the isovector photoproduction amplitude between the predictions of dispersion relations and the experimental data. This discrepancy cannot be removed by the introduction of an isotensor electromagnetic current. For the considered isotopic combination the result practically does not depend on the possible ambiguities in the solution of the dispersion relations. (auth)

32086 INCLUSIVE SOFT-PION PRODUCTION IN INELASTIC egamma SCATTERING. Roy, Probir (Cornell Univ., Ithaca, N. Y. CERN, Geneva). Phys. Lett.; 39B: No. 3, 365-8(1 May 1972).

The differential cross section for producing one or two soft pions in inelastic $e\gamma$ scattering is related to the structure functions describing the Fourier transformed forward matrix elements of the products of two strangeness-conserving weak axial vector or vector currents respectively between spin-averaged identical photon states. (auth)

32087 LIGHT CONE EXPANSION AND CORRECTIONS TO VECTOR MESON DOMINANCE IN COMPTON SCATTERING. Altarelli, G.; Preparata, G. (Univ., Rome). Phys. Lett.; 39B: No. 3, 371-4(1 May 1972).

The corrections to vector meson dominance relating high energy Compton scattering and ρ-photoproduction at $t = 0$ are estimated using the operator expansion near the light cone and the experimental results on deep inelastic electron scattering. (auth)

32088 SCALING IN A DUAL MODEL FOR SINGLE PARTICLE INCLUSIVE ELECTROPRODUCTION. Laudiero, A. (Univ., Naples); Pettorino, R.; Nicodemi, F. Phys. Lett.; 39B: No. 3, 384-8(1 May 1972).

Single particle inclusive electroproduction is studied by means of dual resonance models for currents making use of Müller's theorem. Generalized scaling behavior holds when the photon mass goes to infinity in the target fragmentation region. When the photon mass is kept fixed the two current vertex factorises and the distribution of fragments becomes independent of the mass value. (auth)

32089 MAXIMUM-SPIN-1 PARTICLE CONTRIBUTION TO WAVE MECHANICS. Pereira, Jose Vassalo (Univ., Paris). Port. Phys.; 6: No. 4, 203-306(1971). (In French). Thesis.

A generalization of the theory of the maximum-spin-1 particle is proposed which enables the theory to describe a charged particle moving in an electromagnetic field. The general problem of passing from the relativistic theories to the corresponding nonrelativistic ones is then discussed, in which the importance of the "β-approximation" is stressed. One then calculates the nonrelativistic approximation of the foregoing generalized theory of the particle of maximum spin 1, which brings to light the validity of the so-called "method of fusion" within the frame of nonrelativistic wave mechanics. As a particular case of the preceding results, one is led to the approximation of the Maxwell–De Broglie equations, describing the nonrelativistic behavior of the photon. (auth)

32090 PROTON-NEUTRON MASS DIFFERENCE PROBLEM AND RELATED TOPICS. Zee, A. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rep.; 3C: No. 3, 127-92(Mar-Apr 1972).

The review of the proton–neutron mass difference problem covers the failure of the Born approximation and rapidly decreasing form factors, feedback mechanisms, tadpoles, enhancement theories, ghosts, electroproduction, scaling, and logarithmic divergences, fixed poles, Cottingham rotation, the Dashen calculation, the sidewise dispersion approach, and dominance by tensor trajectories. Also treated are t-channel dynamics, the Harari analysis, soft meson calculation, enhancement theories in the presence of ghosts, the static model and the pattern of mass splitting, electroproduction, scaling, logarithmic divergences, the Bjorken divergence, conspiracy, the fixed pole, and η decay. (J.F.P.)

32091 MASS OF THE PHOTON. IMBERT EFFECT AND GOOS–HAENCHEN EFFECT WITH POLARIZED INCIDENT LIGHT. Vigier, J. P. (Institut Henri Poincare, Paris); de Broglie, Louis. Compt. Rend., Ser. B, 273: No. 25, 1069-73 (20 Dec 1971). (In French).

The use of the quadripotential vector as a real physical field (which results from the introduction of a nonzero mass term in the Maxwell equations) results, by continuity conditions, in a separation (recently observed by Imbert) into only two components of the Goos–Haenchen displacement. The Imbert experiment, contrary to the classical formalism, may be considered as experimental proof of the necessity of abandoning gauge invariance. (France)

32092 PHOTOPRODUCTION OF ETA MESONS IN THE VIRASORO MODEL. Hori, Setsuko; Kawaguchi, Norio (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 1, 340-1(Jan 1972).

The Virasoro model is applied to the $\gamma p \rightarrow \eta p$ process, which has no dips in the observed differential cross sections. It is shown that the differential cross sections are well reproduced in this model without B and H' mesons. (L.B.S.)

32093 UNCORRELATED EFFECT FOR THE NUCLEON AXIAL VECTOR FORM FACTOR. Watanabe, Keiji (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 47: No. 3, 947-57(Mar 1972).

The nucleon axial vector form factor is investigated by using dispersion theory as was done for the isovector part of nucleon electromagnetic form factor: The existence of an axial vector meson $A_1(1070)$ is assumed, and the deviation from A_1 pole approximation is regarded as a consequence of uncorrelated effects of $\rho\pi$ and $\sigma\pi$ intermediate states. A_1' with the mass of about 1.5 BeV is assumed when necessary. From this point of view the experimental data obtained by neutrino reaction and current algebra are discussed. (auth)

32094 LEPTON–HADRON COLLISIONS IN A SUB-URBARYONIC COMPOSITE MODEL. Kakuto, Akira; Kobayashi, Akizo (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 47: No. 3, 971-81(Mar 1972).

The lepton-hadron collisions are studied using a sub-urbaryonic composite model for elementary particles. The model is an analogue of the so-called Nagoya model [Z. Maki, M. Nakagawa and S. Sakata, Prog. Theor. Phys., 28: 675(1962); Z. Maki, Y. Ohnuki and S. Sakata, Prog. Theor. Phys. Suppl. Extra Number, 406(1965)]. The results are compared with the recent experimental data [E. D. Bloom et al., A Report presented to the XV International Conference on High Energy Physics, Kiev, U.S.S.R. (1970), SLAC-PUB-796; I. Budagov et al., Phys. Letters, 30B: 364(1969)] and other models [J. Iizuka, M. Kobayashi and H. Nitto, Prog. Theor. Phys., 45: 482(1971); R. Brandt, Phys. Rev. Letters, 23: 1260(1969)]. (auth)

32095 HELICITY CONSERVATION IN THE PHOTO- AND VECTOR-MESON-REACTIONS. I. Biyajima, Minoru (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 47: No. 3, 1047-8(Mar 1972).

The s-channel helicity conservation hypothesis is investigated for $\gamma\pi \rightarrow \pi\gamma$, $\gamma\pi \rightarrow V\pi$, $\pi V \rightarrow \pi V$ interactions and for photo- and vector-meson reactions from a half-spin target. (L.B.S.)

32096 HELICITY CONSERVATION IN THE PHOTO- AND VECTOR-MESON-REACTIONS. II. DENSITY SPIN MATRIX IN $\gamma p \rightarrow \rho^0 p$ REACTION. Biyajima, Minoru (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 47: No. 3, 1049-50(Mar 1972).

The density spin matrix elements in the $\gamma p \rightarrow \rho^0 p$ interaction are constructed in the Gottfried–Jackson frame, using the s-channel helicity conservation hypothesis and the factorization theorem. It is concluded from comparison with experimental data that s-channel helicity conservation in this reaction does not hold exactly at $E_\gamma = 4.7$ GeV/c. (L.B.S.)

32097 SUM RULE FOR e–p SCATTERING. Okumura, Yoshitaka (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 3, 1054-6(Mar 1972).

A sum rule for ep scattering is investigated, which connects the resonance region of the virtual Compton amplitude to the deep inelastic region where scale invariance holds. (L.B.S.)

32098 $\eta \rightarrow 3\pi^0$ DECAY AND BROKEN SU(3) × SU(3) SYMMETRY. Bose, Subir K. (Southern Illinois Univ., Carbondale). Progr. Theor. Phys. (Kyoto); 47: No. 1, 342-3(Jan 1972).

The tadpole model of $\eta \rightarrow 3\pi$ is reexamined in the framework of broken SU(3) × SU(3) model of Gell-Mann, Oakes, and Renner. An order of magnitude improvement is found in the value of the decay amplitude. (L.B.S.)

32099 SUPERFLUID STATE IN NEUTRON STAR MATTER. III. TENSOR COUPLING EFFECT IN $^3P_2$ ENERGY GAP. Takatsuka, Tatsuyuki (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 3, 1062-4(Mar 1972).

It is pointed out that if a kind of cohesive force of a nonelectromagnetic nature exists and the electron is in a state of stable equilibrium, some kind of small vibrations around the equilibrium position could be expected. This possibility is examined in a preliminary way, by assuming that the electron is a uniformly charged elastic sphere, and considering only the radial vibration. (L.B.S.)

32100 GENERALIZED VECTOR DOMINANCE MODEL AND DEEP INELASTIC ELECTRON–MESON SCATTERING. Hama, Mitsuru (Dalhousie Univ., Halifax, Nova Scotia); Kiang, David;

Sumi, Yoshio. Progr. Theor. Phys. (Kyoto); 47: No. 3, 908-18 (Mar 1972).

The scale invariance of the structure function for inelastic electron-meson scattering is investigated by taking into account a family of an infinite number of vector mesons suggested from the dual resonance model. The Pomeron contribution is included in an intuitive way. It is shown that firstly, scale invariance holds even when the transversely polarized photoabsorption cross section dominates over the longitudinal one. Secondly, both the Pomeron and dual resonance contributions are scale-invariant nontrivially only if the total cross sections of the vector meson-meson scattering is inversely proportional to the square of the masses of the heavier vector mesons. In both cases the form factor of the scalar meson has a definite asymptotic behavior. (auth)

32101 e^+e^- ANNIHILATION STRUCTURE FUNCTION IN THE DUAL-RESONANCE MODEL. **Niegawa, A. (Kyoto Univ.). Lett. Nuovo Cim.; 3: No. 17, 684--8(22 Apr 1972).**

Various features of the Kikkawa–Sata dual-resonance model with current are pointed out. The behavior of the e^+e^- annihilation structure function $\overline{W}_2$ in the deep annihilation region is studied within the Kikkawa–Sata model with the planar one-loop approximation. It is shown that, in general, $\nu\overline{W}_2$ diverges in the Bjorken limit but $\overline{W}_2$ may have a finite limit. It is concluded that if $\nu\overline{W}_2$ is to scale, the target meson mass must be quantized. (L.B.S.)

32102 REACTION $e^+e^- \rightarrow \pi^+\pi^-\pi^+\pi^-$ AND THE ρ'-MESON. Bramon, A.; Greco, M. (CNEN, Frascati, Italy). Lett. Nuovo Cim.; 3: No. 17, 693-7(22 Apr 1972).

Previous attempts to explain the data on $e^+e^- \rightarrow \pi^+\pi^-\pi^+\pi^-$ interactions, assuming the existence of the ρ' meson, are reexamined in light of new experimental information, and the implications concerning this process are analyzed. (L.B.S.)

32103 DEEP INELASTIC ELECTRON–PROTON SCATTERING IN THE PROTON FRAGMENTATION REGION. **Galfi, L. (Lorand Eoetvoes Univ., Budapest); Hasenfratz, P. Lett. Nuovo Cim.; 3: No. 17, 702-7(22 Apr 1972).**

The one-particle distribution in the reaction e + p → e + hadron + anything in the fragmentation region of the target proton is calculated. Mueller's generalized optical theorem and the single Regge expansion are used to connect the process with deep inelastic electron-proton scattering and the hadron + p → hadron + anything reaction. Predictions are found to be in good agreement with experiment. (L.B.S.)

32104 SOLUTION FOR SOME CURRENT CONSERVATION EQUATIONS. **Stern, H. (CEN de Saclay, Gif-sur-Yvette, France). Nuovo Cim.; 9A: No. 1, 43-61(1 May 1972).**

The constraint equations imposed by the conservation of the electromagnetic current on the amplitudes describing the electromagnetic vertex, the π photoproduction and the Compton effect on a target of arbitrary spin are formally solved; the solution is manifestly Lorentz covariant and analytic in the holomorphy domain assumed for the amplitudes. (auth)

32105 ELECTROMAGNETIC FORM FACTORS OF BARYONS AND MESONS AND UR-CITON SCHEME. Ishida, Shin; Konno, Kimiaki; Yamazaki, Yasuhito (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 47: No. 1, 317-31(Jan 1972).

The electromagnetic form factors of nucleons are investigated in the ur-citon scheme which was proposed recently for a unified and relativistic treatment of all hadrons, including heuristically the successful results of the quark model. As a result it is shown to lead the famous experimental behavior, scaling law and the dipole-like asymptotic behavior. The transition form factor between nucleon and (3–3) resonance and the pion form factor are investigated also by the same method to lead satisfactory results. (auth)

Weak

Refer also to abstracts 32019 and 32206.

32106 (CERN–72-4) VERY ELEMENTARY THEORY OF WEAK INTERACTIONS. **Bell, J. S. (European Organization for Nuclear Research, Geneva (Switzerland)). 8 Mar 1972. 28p. Dep. NTIS (U. S. Sales Only).**

The lectures on weak interactions cover the Dirac theory, interactions, V–A theory, semileptonic interactions, current-current interactions, the intermediate boson, and CP violation. (J.F.P.)

32107 (ITEF–862) ANGULAR AND MOMENTUM DISTRIBUTION OF μ^+-MESONS (OR POSITRONS) IN REACTIONS OF DIRECT PRODUCTION OF LEPTON PAIRS BY A NEUTRINO BEAM IN AN ELECTROMAGNETIC FIELD OF NUCLEI AND NUCLEONS. **Berkov, A. V.; Voronina, L. M.; Shabalin, E. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1971. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).**

Calculations are presented for doubly differential spectra $\mu^+(e^+)$ in the reactions $\nu_\mu + Z \rightarrow \mu^- + \mu^+ + \nu_\mu + Z$ and $\nu_\mu + Z \rightarrow \mu^- + e^+ + \nu_e + Z$, taking place in an electromagnetic field of nucleons and iron nuclei. The calculations include the range of energies of the original neutrino from 2 to 100 GeV. (tr-auth)

32108 (ORO–3992-15) WEAK INTERACTIONS. **Nilsson, Jan (Texas Univ., Austin. Center for Particle Theory). Jan 1972. Contract AT(40-1)-3992. 81p. (CPT–56; CONF-700424–3). Dep. NTIS.**

From Symposium on the past decade in particle theory; Austin, Tex. (14 Apr 1970).

The review of weak interaction theory covers the emerging theory, current × current theory, the experimental status of the empirical selection rules, the Cabibbo model for the hadron current, SU(3) × SU(3) current algebra, and the conserved vector current hypothesis and the partial conservation of axial vector current. The Goldberger–Treiman relation and the Adler–Weisberger sum rule, low-energy theorems and current algebra, and some open questions are also treated. (J.F.P.)

32109 WEAK INTERACTIONS. **Nilsson, Jan (Inst. of Theoretical Physics, Goteborg). Fields Quanta; 2: No. 4, 293-373(Apr 1972).**

Developments in weak interaction theory during the past decade are reviewed, and some major contributions made prior to 1960 are briefly outlined. (J.F.P.)

32110 RATIO OF THE NONMESONIC AND π^--MESON DECAYS PROBABILITIES AND THE POTENTIAL WELL DEPTH FOR Λ IN A HYPERNUCLEUS. Filimonov, V. A. (Tomsk Polytechnic Inst., USSR). Yadern. Fiz.; 15: No. 2, 334-9(Feb 1972). (In Russian).

A phenomenologic model of π^--meson decays of heavy hypernuclei is proposed which permits one to calculate the mass number (A) dependence for the ratio (Q^-) of the nonmeson and π^--meson decay probabilities. The model takes into consideration three reasons for the suppression of the π^--meson decays: the Pauli principle which forbids the $\Lambda \rightarrow p\pi^-$ decay when Λ-hyperon is inside the nucleus-core; a decreasing of the phase space owing to an increasing of the Λ bound energy as A increases; an absorbing of π^--mesons in the nuclear matter. The character of the Q^- increasing as A increases depends essentially on the potential well depth (D_Λ) of Λ in the hypernucleus and on the thickness of the nuclear surface layer. The well depth for Λ in hypernuclei is estimated as $D_A \approx 30$ MeV from the experimental value of Q^-. (auth)

32111 $\mu^+ \rightarrow e^+\nu_e\bar{\nu}_\mu e^+e^-$ DECAY. Bardin, D. Yu.; Istatkov, Ts. G.; Mitsel'makher, G. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 15: No. 2, 284-7(Feb 1972). (In Russian).

The detailed $\mu^+ \rightarrow e^+\nu_e\bar{\nu}_\mu e^+e^-$ process calculation in the lowest order of the weak and electromagnetic interactions is carried out. The results obtained are compared with experimental data. (auth)

32112 EFFECTS OF A NEUTRAL INTERMEDIATE BOSON IN SEMILEPTONIC PROCESSES. **Weinberg, Steven (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 5: No. 6, 1412-17(15 Mar 1972).**

The observable effects of a neutral intermediate vector boson in semileptonic processes are considered in the context of a proposed renormalizable theory of the weak and electromagnetic interactions. With strange particles neglected, this theory allows the calculation of neutral-current form factors in terms of charged-current form factors and electromagnetic form factors. The results are neither confirmed nor refuted by present data. One possible method of incorporating the strange particles is briefly discussed. (auth)

32113 HIGH-ENERGY LIMIT OF LOWEST-ORDER WEAK AMPLITUDES WITH ELECTROMAGNETIC RADIATIVE CORRECTIONS IN THE LADDER APPROXIMATION. **Chaudhuri, R. N.; Malik, G. P. (Univ. of Delhi). Phys. Rev., D; 5: No. 6, 1370-5 (15 Mar 1972).**

The asymptotic lowest-order weak amplitude for the process $\nu_\mu + \nu_e \rightarrow \mu^- + e^+$ is found to be modified by a factor $\exp[-(\alpha/2\pi) \ln t]$ on account of radiative corrections in the ladder approximation. This is in conformity with the result obtained earlier by Li in the perturbation theory. (auth)

32114 SPIN-ZERO INTERMEDIATE BOSON FOR WEAK INTERACTIONS. **Deshpande, Nilendra G.; McNamee, Peter**

C. (Northwestern Univ., Evanston, Ill.). Phys. Rev., D; 5: No. 6, 1389-97(15 Mar 1972).

It is shown that a spin-0 boson which is described by the Kemmer–Duffin formalism can mediate weak interactions. In the low-momentum-transfer limit results are obtained which are equivalent to the ordinary Fermi interaction. Properties of this meson are discussed and the rates for some of its decay modes are calculated. These rates are, in general, much lower than the rates predicted by the usual spin-1 intermediate-meson model. Production amplitudes are also presented. (auth)

32115 RELATIONS AMONG THE STRUCTURE FUNCTIONS OF DEEP-INELASTIC NEUTRINO–NUCLEON SCATTERING. Dicus, Duane A. (Univ. of Rochester, N. Y.). Phys. Rev., D; 5: No. 6, 1367-70(15 Mar 1972).

Light-cone current commutators are used to derive relations between the structure functions of the vector-vector part of neutrino-nucleon scattering and the structure functions of the vector–axial-vector part. (auth)

32116 $K_L \rightarrow 2\mu$ DECAY AND POSSIBLE EXISTENCE OF NEW NEUTRAL K-MESONS. Nikolaev, N. N. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett.; 39B: No. 2, 263-4(17 Apr 1972).

It is shown that the observed suppression of $K_L \rightarrow \mu^+\mu^-$ decay rate may be explained by possible existence of new neutral K-mesons and the definite predictions are obtained in the model proposed earlier to serve CP-invariance in neutral K-meson decays. (auth)

32117 DIVERGENCE CANCELLATIONS IN A SIMPLIFIED WEAK INTERACTION MODEL. Appelquist, T.; Quinn, Helen (Harvard Univ., Cambridge, Mass.). Phys. Lett.; 39B: No. 2, 229-32(17 Apr 1972).

The divergence structure of a simplified (abelian) model of weak interactions is examined in low orders of perturbation theory. The model utilizes the Higgs mechanism of spontaneous violation of local gauge symmetry to generate a vector meson mass. It is found that the only divergences of on-mass-shell S-matrix elements are those corresponding to conventional renormalization effects. (auth)

32118 IMPLICATIONS OF THE QUARK–GLUON LIGHT CONE CURRENT ALGEBRA ON NEUTRINO SCATTERING. Ng, W. C. (New York Univ., N. Y.); Vinciarelli, P. Phys. Lett.; 39B: No. 2, 219-22(17 Apr 1972).

The explicit canonical structure of the light cone restriction of the commutator of the weak current with its divergence is considered in the interacting quark-gluon model quantized in the finite momentum frame. The implications on neutrino scattering are analyzed. W_4 and W_5 are predicted to scale nontrivially as $\nu^{-2} F_4(\omega)$ and $\nu^{-2} F_5(\omega)$, which provides a simple test of light cone current algebra feasible in the near future. The Σ-term for weak currents is deduced from a causal representation near the light cone, and a correction is also made in the W_5-sum rule obtained by naive infinite momentum techniques. (auth)

32119 NEUTRINO EXCITATION OF NUCLEON RESONANCES IN A QUARK MODEL. Ravndal, F. (California Inst. of Tech., Pasadena). Lett. Nuovo Cim.; 3: No. 15, 631-6(8 Apr 1972).

A relativistic formulation of the symmetric quark model is applied to the process $\nu + N \rightarrow l^- + N^*$. The model provides definite axial-current matrix elements which can be used together with the vector-current matrix elements to predict excitation cross sections for nucleon resonances. Specific application is made to the $\nu + p \rightarrow l^- + p_{33}^{++}$ interaction. (L.B.S.)

32120 NEUTRINO–NUCLEON SCATTERING AND THE DIMENSION OF THE SYMMETRY-BREAKING HAMILTONIAN. Brown, S. G. (Univ. of California, Los Angeles). Phys. Lett.; 39B: No. 3, 399-401(1 May 1972).

Some implications of an analysis of neutrino–nucleon scattering using Wilson operator-product-expansions are presented: (A) If the divergence of the axial vector current behaves as a canonical pion field, then there exists an operator of dimension ≤ 0. (B) A "maximal contribution assumption" implies that Δ, the dimension of the SU(3) $\otimes$ SU(3) breaking Hamiltonian, is ≥ 2. Implications for internal symmetry of the vanishing of W_L are also discussed. (auth)

32121 BROKEN CHIRAL SYMMETRY: K_{l3} DECAY AND THE CONSISTENCY CONDITION. Takasugi, Eiichi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 3, 958-64(Mar 1972).

The K_{l3}-form factor is studied on the basis of the GMOR model within the framework of the one-particle saturation. Various predictions are made without recourse to any other assumptions. It is predicted that the κ-meson mass m_κ must satisfy the inequality $m_\kappa \leq m_K + m_\pi$ and that $\xi(0) = -1.12$ and $\lambda_0 = -0.028$ provided $f^{(+)}(0) = 1$ and $\lambda_+ = 0.06$. (auth)

32122 NOTE ON THE LEPTONIC DECAYS OF CHARMED MESONS. Kondo, Hiroki; Maki, Ziro; Maskawa, Toshihide (Saga Univ., Japan. Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 3, 1060-2(Mar 1972).

A new approach to the quartet model of hadrons was previously proposed based on the combined use of the principle of lepton-baryon symmetry and an approximate chiral U(4) × U(4) symmetry realized with the Nambu–Goldstone bosons. Some of the direct consequences of this scheme for the decays of the charmed members of the Nambu–Goldstone bosons into leptons are pointed out. (L.B.S.)

32123 LOW-ENERGY THEOREMS AND NEUTRINO–NUCLEON SUM RULES. McKenzie, Nigel C. (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 1, 246-59(Jan 1972).

Low energy theorems are derived for the Compton-type scattering of combinations of the strangeness non-changing vector and axial vector currents. These are then used to obtain new sum rules for νN cross sections at $Q^2 = 0$. (auth)

32124 NOTE ON THE NONLEPTONIC HYPERON DECAYS AND AN SU(3)-SINGLET BARYON. Katuya, Mituaki (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto); 47: No. 1, 332-3 (Jan 1972).

An investigation is made of the nonleptonic decays, especially s-wave and p-wave decays of Λ and Ξ, on the basis of a simple pole model in which those of the Σ may be explained. (L.B.S.)

32125 COMMENTS ON OMEGA-NONLEPTONIC DECAY. Toyoda, Akira; Furui, Sinya; Tsuchida, Tetsuya (Ibaraki Univ., Mito, Japan). Progr. Theor. Phys. (Kyoto); 47: No. 1, 336-7 (Jan 1972).

The $\Omega^- \rightarrow K^- + \Lambda$ (decouplet) decay is examined in accordance with the features suggested by the effective interaction Hamiltonian given for octet baryon nonleptonic decay. A possible parallelism is suggested between octet and decuplet baryon decays. (L.B.S.)

32126 NEUTRINO–HADRON PROCESSES IN WEAK INTERACTIONS, INCLUDING A THIRD NEUTRINO. Romanov, Yu. I. Izv. Yssh. Ucheb. Zaved., Fiz.; No. 7, 13-17(1971). (In Russian).

A scheme which describes the weak interaction of leptons and hadrons is discussed, including an "odd" s-neutrino. The s-neutrino, unlike the electron or muon, arises during lepton decay of hyperons and kaons. The possibility of experimental confirmation of the existence of a third neutrino is discussed. (tr-auth)

32127 KAPPA-RESONANCE AND EFFECTIVE-RANGE APPROXIMATION FOR $(K\pi)$ S-SCATTERING IN SUM RULES FOR THE K_{l3} FORM FACTORS. Zerwas, P. (Technische Hochschule, Aachen). Nuovo Cim.; 9A: No. 1, 97-106(1 May 1972).

Using the technique of the collinear parametrization, sum rules for the K_{l3} decay form factors are derived from charge-current and charge-current-divergence commutators. The contribution from the 0^+ continuum with isospin $\frac{1}{2}$ and strangeness 1 approximated by a kappa-particle is compared with that from a $(K\pi)$ continuum. The $(K\pi)$ phase shift can be approximated by an effective-range formula where Weinberg's value is taken for the scattering length. The results of both approaches agree remarkably well, so that the replacement of the $(K\pi)$ 0^+ cut by an effective κ pole is to some degree justified. (auth)

32128 LEPTON NONCONSERVATION IN NUCLEAR PHYSICS. Fiorini, E. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Riv. Nuovo Cim.; 2: No. 1, 1-24(Jan-Mar 1972).

The following topics are discussed in a review on lepton nonconservation in nuclear physics: lepton schemes and muon capture; experiments on the conservation of the lepton number; evaluation of the limit of the lepton-nonconserving parameter; and consequences of leptonic nonconservation in nuclear astrophysics and cosmology. (L.B.S.)

Strong (General)

Refer also to abstract 32227.

32129 (ORO–3992-84) EVIDENCE FOR REGGE POLES AND HADRON COLLISION PHENOMENA AT HIGH ENERGIES. Chiu, Charles B. (Texas Univ., Austin. Center for Particle Theory). Apr 1972. Contract [AT(40-1)-3992]. 102p. (CPT–138). Dep. NTIS.

Experimental evidence for Regge trajectories is reviewed. And high-energy two-body collision phenomena are surveyed and the success and the failure of the Regge pole model are correlated to the low impact parameter behavior of the Regge pole terms. In the course of discussion, a critical evaluation of the various absorption models is also presented. Based on the Regge model for peripheral scattering and the statistical model for central collision, a strong absorption prescription is suggested for high energy two-body scattering. (auth)

32130 (RLO–2041-65) DISPERSION RELATIONS IN THE TRANSVERSE MOMENTUM FOR FIXED s. Yu, Wing-Yin; Moravcsik, Michael J. (Oregon Univ., Eugene). [1971]. 9p. Dep. NTIS.

In view of the phenomenological evidence that the differential cross section depends strongly on p_t^2 and weakly on s, it is proposed to write dispersion relations in p_t^2 for fixed s. Some applications are indicated. (auth)

32131 ONCE MORE VARIANT OF ABSORPTIVE ONE PION EXCHANGE MODEL. Guzhavin, V. M.; Dubovikov, M. S. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 15: No. 2, 351-60(Feb 1972). (In Russian).

A postulate somewhat different from the one accepted in the fundamental papers of Jackson et al., the difference of the postulates leading to the resulting differences of no more than several percents, is used for the exact calculation of an absorptive one-pion-exchange model (OPEA). A very simple computer program is proposed which may be conveniently used for processing of the experimental data in OPEA. The Jackson and proposed methods are compared. (auth)

32132 OPERATOR FORMULATION OF A DUAL MULTIPARTICLE THEORY WITH NONLINEAR TRAJECTORIES. Coon, Darryl D. (Univ. of Pittsburgh); Yu, S.; Baker, M. Phys. Rev., D; 5: No. 6, 1429-33(15 Mar 1972).

An operator formalism for a dual-resonance theory with nonlinear trajectories is presented and an explicit, factorized operator representation is obtained for the N-point function. Operator Ward identities are also given. (auth)

32133 ONE-LOOP RENORMALIZATION OF THE NONLINEAR σ MODEL. Bessis, D.; Zinn-Justin, J. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Rev., D; 5: No. 6, 1313-23(15 Mar 1972).

A method is proposed for regularizing and renormalizing the nonlinear σ model based on the limit of the linear σ model when the σ mass tends to infinity. The linear σ model being renormalized using Ward identities, this procedure ensures automatically the soft-pion theorems. It also retains the properties of transformations of the Green's functions under the chiral group. In the one-loop approximation, it is shown that the pion propagator has a finite limit when the σ mass tends to infinity, while the four-pion Green's function diverges only logarithmically with the σ mass. (auth)

32134 INCONSISTENCY IN THE VALUE OF THE D/F RATIO FOR THE AXIAL-VECTOR CURRENT. Kaushal, V.; Khanna, M. P. (Panjab Univ., Chandigarh, India). Phys. Rev., D; 5: No. 6, 1541-2(15 Mar 1972).

The model for a strong-interaction Hamiltonian proposed by Gell-Mann, Oakes, and Renner is used to determine the D/F ratio for the axial-vector current. An inconsistency in the values of the D/F ratio is observed. (auth)

32135 POMERANCHUK HYPOTHESIS FOR INELASTIC REACTIONS. Cornille, H. (Institut de Physique Nucleaire, Orsay, France); Martin, A. Phys. Lett.; 39B: No. 2, 223-5 (17 Apr 1972).

Arguments are given to support the belief that fragmentations of a target by a particle and its antiparticle occur with equal cross sections in the high energy limit. (auth)

32136 FEYNMAN'S SCALING IN HIGH ENERGY MULTIPLE HADRON PRODUCTION. Feinberg, E. L. (Lebedev Inst. of Physics, Moscow). Phys. Lett.; 39B: No. 2, 237-9(17 Apr 1972).

The various arguments put forth by theorist and experimentalists on Feynman scaling and the inclusive spectrum of particles produced in high-energy interactions are discussed and revised. The importance of experimental evidences from cosmic ray data is also pointed out. (L.B.S.)

32137 CHARACTER OF THE ASYMPTOTIC REGIME IN HIGH-ENERGY HADRON COLLISIONS. Ginzburg, I. F. Phys. Lett.; 39B: No. 2, 214-18(17 Apr 1972).

On the grounds of generalized multiperipheral model, it is shown that the main scattering characteristics should become asymptotic at $s \gtrsim 500$ GeV^2. The behavior of diffraction cone slope, total cross sections and multiplicity is discussed from this viewpoint. Effective violation of scaling for $x \lesssim 0.05$, a weak increase of the transverse momentum and a rapid increase of multiplicity $n \approx 2.5 \ln s + d$ at $s \gtrsim 500$ GeV^2 are predicted. (auth)

32138 EIKONALIZATION WITH ρ MESON EXCHANGE. Chang, L. N. (Univ. of Pennsylvania, Philadelphia); Segre, G.; Chang, N. P. Phys. Lett.; 39B: No. 2, 207-10(17 Apr 1972).

The t-channel discontinuity of the part of the hadron hadron scattering amplitude due to exchange of an arbitrary number of ρ mesons is calculated in the resonance approximation. The answer has an eikonal form with several simple features. (auth)

32139 CASE FOR A QUARTET MODEL OF HADRONS. Carlson, C. E. (Univ. of Chicago); Freund, P. G. O. Phys. Lett.; 39B: No. 3, 349-52(1 May 1972).

A model of hadrons based on an underlying quartet leads to a more satisfactory picture of weak interactions than one based on a triplet. Hadrons containing the fourth type of quark may be as low as 700 MeV above their uncharmed counterparts. It is argued that charmed hadrons should be searched for in photoproduction and (under certain circumstances) in hadronic formation experiments. (auth)

32140 GAUGE CONDITIONS IN DUAL RESONANCE MODELS. Mansouri, F. (Univ. of Chicago); Nambu, Y. Phys. Lett.; 39B: No. 3, 375-8(1 May 1972).

Simplifying the arguments of Chang and Mansouri, it is shown that the Virasoro conditions in dual resonance models are related to geometrical and mechanical properties of classical two-dimensional media. (auth)

32141 TESTING THE PARTON MODEL IN MASSIVE LEPTON PAIR PRODUCTION. Gronau, M. (California Inst. of Tech., Pasadena). Phys. Lett.; 39B: No. 3, 395-8(1 May 1972).

The parton model and the conjectured diffraction behavior of $F_2^{\gamma N}(x)$ at small x are used to establish a relationship between the deep inelastic electroproduction process and massive lepton pair production. The result is applied to present and future experiments. (auth)

32142 DYNAMICS OF ELEMENTARY PARTICLES DERIVED FROM RELATIVISTIC QUARK MODELS. Dias de Deus, J. (University Coll., London). Port. Phys.; 7: No. 1-2, 3-85(1971).

The interactions of hadrons are described from the point of view of quarks. Weak, electromagnetic and strong coupling constants are evaluated with a relativistic quark model using the Bethe–Salpeter formalism. Uniquely defined SU(3) mass breaking factors are derived from the quark dynamics inside the mesons. A dualized approach to the classic quark model connecting the low and high energy predictions is proposed and a simple model for the four-body amplitude satisfying duality and the additive quark model is applied in the determination of meson-baryon low energy parameters. Analogous calculations are also shown for the hypothetical quark-meson process. Quark duality diagrams are used to constrain dual resonance amplitudes. One of these constraints takes the form of a superconvergent relation to be saturated in local mass regions. These relations are studied for various processes both in the forward and backward direction. (auth)

32143 FISHBANE CONJECTURE IN THE GALILEAN INVARIANT LEE MODEL. Uliu, F. S. (Univ., Craiova, Romania). Acta Phys. Pol., B3: No. 2, 333-5(Mar-Apr 1972).

A conjecture of Fishbane (P. M. Fishbane, Phys. Rev., 177(II), 2323(1969)) is investigated in the framework of Gali-Lee model. It is found that this conjecture is true. (auth)

32144 LEE MODEL WITH V PARTICLE HAVING CONTINUOUS SPECTRUM OF ASYMPTOTIC MASSES. Lukierski, J.; Oziewicz, M. (Univ., Wroclaw). Acta Phys. Pol., B3: No. 2, 231-46(Mar-Apr 1972).

Problems related with the field-theoretic description of unstable particles are studied. The Lee model is introduced with the V-particle replaced by a general unstable elementary object with continuous mass spectrum. The model is completely solved in the lowest $N\theta$ sector. The analytic continuation on the second Riemann sheet of the scattering amplitudes and the analytically continued unitarity condition are considered. The derivation of the reduction formula with complex mass shell is presented. Finally the equivalence is shown of this model in $N\theta$ sector with the conventional Lee model with four-leg direct interaction. (auth)

32145 MULTIPLICITY FLUCTUATION AND MULTIPARTICLE DISTRIBUTION FUNCTIONS IN HIGH-ENERGY COLLISIONS. Quigg, C.; Wang, Jiunn-ming; Yang, Chen Ning (State Univ. of New York, Stony Brook). Phys. Rev. Lett.; 28: No. 19, 1290-3(8 May 1972).

Speculations are made concerning the fluctuation in the multiplicity in the fragmentation of hadrons in high-energy collisions. Implications for the two-particle distribution function ρ_2 and higher-order distributions ρ_ν are analyzed. (auth)

32146 QUARTET MODELS BASED ON FUNDAMENTAL PARTICLES WITH FRACTIONAL CHARGE. Kobayashi, Makoto; Nakagawa, Masami; Nitto, Hidemitsu (Nagoya Univ., Japan Meijo Univ., Nagoya, Japan). Progr. Theor. Phys. (Kyoto); 47: No. 3, 982-95(Mar 1972).

Some quartet models based on fractionally charged ur-baryons are discussed in terms of a broken SU(4) symmetry. Mass spectra of baryons and mesons are calculated, which include a result of recent observation of cosmic ray jet shower. Further implications on weak interactions are also discussed. An explicit form for universal weak currents and new selection rules for non-leptonic and radiative decays which hold exactly in the limits of SU(3) and SU(4) are given. (auth)

32147 DETAILED WAVE EQUATION FOR EXTENDED MODEL UNDERLYING THE DUAL AMPLITUDE: STRING MODEL OF HADRONS AND ITS HYBRID EXTENSION. Takabayasi, Takehiko (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 47: No. 3, 1026-46(Mar 1972).

The theory of detailed wave equation (DWE), which represents relativistic quantum dynamics of an extended system with external interaction for a specific value of Regge intercept, avoiding ghost states and leading to dual amplitude, is further developed in several respects. The original formulation (the σ-formalism) for the string model is transcribed into a few equivalent formalisms. In the λ-formalism the invariance of DWE against the "Hilbert transform" becomes manifest. Finite "gauge transformations," under which the theory is invariant, are explicitly obtained for the consideration of their structural meaning. The original string model is generalized to the hybrid model, where each element constituting the string is endowed with internal "Fermi oscillator variables," in the framework of DWE, which now fixes the Regge intercept at the value lower than the original one by $1/2$ unit or its multiples. In particular the hybrid model with vector Fermi variables, which implies "double-string" consisting of Dirac-like elements, is treated, where the vector Fermi variables differ from those in similar models by other authors with respect to their reality and Lorentz properties and are free from the introduction of additional indefinite metric. Moreover the theory is invariant under space reflection. (auth)

32148 TWO-PARTICLE DISTRIBUTIONS IN THE DUAL RESONANCE MODEL. Sakai, Sunao (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 1, 260-71(Jan 1972).

Two-particle distributions are investigated in the framework of the dual resonance model. The distribution functions have the limit in the following cases: (i) the particles produced are both in the same fragmentation region of the target or the projectile, (ii) both particles are in the pionization region, and (iii) one is in the fragmentation region of the target and the other is in that of the projectile. However, in the case that one is in the fragmentation region while the other is in the pionization region, the distribution function decreases rapidly. In the limiting distribution of case ii, the distribution function shows exponential cutoff with respect to the transverse momentum of the produced particles in the rest frame of the target. (auth)

32149 VENEZIANO MODEL AND COMPLEX REGGE POLES. Tsarev, V. A. Kratk. Soobshch. Fiz.; No. 11, 33-6(Nov 1971). (In Russian).

Trajectories and branch points are discussed in connection with Regge poles, and the trajectory concept is explored with the aid of a Veneziano model. (K.S.W.)

32150 PRODUCTION OF KAONS AND BARYON–ANTIBARYONS AT A FEW TeV ENERGY. Malhotra, P. K.; Raghavan, R. (Tata Inst. of Fundamental Research, Bombay). Nuovo Cim.; 9A: No. 1, 75-84(1 May 1972).

Available emulsion data on nuclear interactions produced by neutral and charged secondary particles emitted from jets with a median primary energy of about 5 TeV were analyzed to deduce information on the proportion of kaons and baryon-antibaryons among the created particles. Using a value of $0.15^{+0.05}_{-0.02}$ for the proportion of baryon-antibaryons (charged and neutral), recently obtained by Tonwar et al., a value of $0.18^{+0.05}_{-0.07}$ was deduced for the proportion of charged and neutral kaons at primary energies in the region of 5 TeV. Kaons and baryon-antibaryons together constitute 0.33 ± 0.07 of all created particles. It is shown that the existing experimental information is consistent with these results. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 32264.

32151 (FRNC-TH-149) THEORETICAL STUDY OF THE $\pi-\pi$ INTERACTION. Bonnier, Bernard (Paris Univ. (France). Faculte des Sciences). 1971. 120p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The kinematics of $\pi\pi$ scattering are studied using the results of field and unitarity theory, the assumption that the nearest singularities are dominant being made for the partial waves. The phase shift variation with energy is demonstrated; in particular the scattering length of the S wave can not exceed a lower limit which is exactly expressed in terms of only the pion mass. The structure of the S and D partial waves and their parametrization are studied in the framework of a neutral theory. The methods are extended to treat the case of low energy $\pi\pi$ interactions. Three stages are considered: S waves, S and P waves, and S, P, and D waves. These parametrizations precisely predict the assembly of 5 phase shifts without contradicting the known consequences of field and unitarity theory; the phenomenological postulate of the existence of a rho meson leads to agreement with experimental results. (France)

32152 (IS-2813) TREATMENT OF $\eta \rightarrow \pi\pi\gamma$ DECAY WITH CROSSING TO OBTAIN INFORMATION ON THE A_2 MESON. Young, B.-L.; Lassila, K. E. (Iowa State Univ. of Science and Technology, Ames. Dept. of Physics. Ames Lab., Iowa). [1971]. 16p. (CONF-720409-1). Dep. NTIS.

From Conference on meson spectroscopy; Philadelphia, Pa. (28 Apr 1972).

The method of Aviv and Nussinov is used to examine the A_2 direct channel contribution to the $\eta\pi \rightarrow \pi\gamma$ reaction through use of decay information on $\eta \rightarrow \pi\pi\gamma$ and crossing. Models for the A_2 with a broad resonance, e.g., a single Breit–Wigner or a wide resonance in the broad-narrow model, readily can satisfy the restrictions following from the $\eta \rightarrow \pi\pi\gamma$ decay rate. Models with two separate poles as in the high-low picture or particularly those attributing different J^P to different halves of the A_2 are considerably strained to satisfy the limits on the coupling parameters. (auth)

32153 (LNF-71/98) MODEL DIFFRACTION TERM. Pancheri-Srivastava, G.; Srivastava, Y. N. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 21 Dec 1971. 8p. Dep. NTIS (U. S. Sales Only).

A modification of the Del Giudice–Veneziano ansatz for the Pomeron is presented. Also off-shell Pomeron amplitudes are constructed and continuous PCAC is imposed for the dual Veneziano terms. Scattering lengths for $\pi\pi$ and $K\pi$ scattering are found, and the threshold cross sections are calculated for $K^+ + \pi^-$ scattering. The Pomeron parts of the amplitudes for $K\pi \rightarrow K\pi$ and $K\pi \rightarrow KA_1$ are related using PCAC. Finally the ratio of the integrated diffraction cross sections for $\pi N \rightarrow \pi(A_1)N$ is computed. (J.F.P.)

32154 (NP-19287) EPSILON PRODUCTION IN A GEOMETRICAL APPROACH. Note No. 357. Garcia Canal, C. A.; Ferro Fontan, C.; Violini, G. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 9 Feb 1972. 7p. Dep. NTIS (U. S. Sales Only).

Using dual properties it was previously qualitatively shown that pion exchange dominates near the forward direction and there is a small exchange with A_1 quantum numbers for ϵ production. It is quantitatively shown that the dual predictions are in agreement with the experimental data. (J.F.P.)

32155 COUPLINGS TO VECTOR MESONS IN THE RELATIVISTIC QUARK MODEL. Dias de Deus, J. (University Coll., London). Port. Phys.; 6: No. 3, 163-81(1971).

Hadron couplings are evaluated using quark graphs and the Bethe–Salpeter formalism. Electromagnetic decays of vector mesons calculated in this way are shown to be consistent with the $\omega-\varphi$ current mixing model. A value $\theta = 33°$ is predicted. Baryon couplings are discussed in the same formalism. When nonrelativistic conditions are imposed the model reproduces the usual additivity results with corrections. (auth)

32156 NORMALIZATION OF THE $\pi\pi$ VENEZIANO MODEL USING A MULTIPERIPHERAL MODEL WITH π, K, AND ω EXCHANGE. Balazs, L. A. P.; Dixit, V. V. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 5: No. 6, 1422-9(15 Mar 1972).

A model of the Amati–Bertocchi–Fubini–Stanghellini–Tonin (ABFST) type with ω and K exchange, in addition to the usual pion exchange, is considered. Instead of using the usual formalism, the ABFST $\pi\pi \rightarrow \pi\pi$ graphs are summed approximately by projecting out into crossed-channel partial waves (which can be continued to unphysical angular momenta) and constructing a diagonal Padé approximant. This satisfies unitarity exactly in the elastic region of that channel. In practice only the [1,1] approximant was considered. The relevant graphs are then built up from $\pi\pi \rightarrow \pi\pi$, $\pi\pi \rightarrow \pi\omega$, and $\pi\pi \rightarrow K\overline{K}$ input kernels, each of which is approximated by Veneziano-model resonances with a cutoff at the mass of the J = 3 resonance and with off-shell effects neglected. By requiring that there be an output pole at $t \simeq 0$ in the unphysical $I = 1$, $J = \frac{1}{2}\pi\pi$ state and that its residue be consistent with the one predicted by the $\pi\pi$ Veneziano model, the normalization coefficient $\overline{\beta}$ of that model can be predicted. $\overline{\beta} = 0.65$ is obtained, which corresponds to a ρ width of 135 MeV. (auth)

32157 SOME SIMPLE RESULTS ON THE DUALITY OF NON-PARITY-DOUBLED SYSTEMS. Jones, Lorella (Univ. of Illinois, Urbana). Phys. Rev., D; 5: No. 6, 1434-6(15 Mar 1972).

It is shown that in some cases the crossing relations and kinematic behavior of helicity amplitudes alone suffice to rule out combinations of mutually bootstrapping trajectories. In particular, no set of g = −natural-parity trajectories can bootstrap itself in the reaction $\pi\rho \rightarrow \rho\pi$; and no set of meson trajectories of definite (natural or unnatural) parity can be self-dual in baryon-antibaryon or quark-antiquark scattering. The techniques described are most useful when the number of independent helicity amplitudes involved in the reaction is small, and several of these can be associated with definite parity for exchanged trajectories. (auth)

32158 INVARIANT AMPLITUDES FOR STUDYING THE PARITY CONTENT OF DUALITY. Jones, Lorella (Univ. of Illinois, Urbana). Phys. Rev., D; 5: No. 6, 1437-44(15 Mar 1972).

Kinematic-singularity-free parity-conserving helicity amplitudes are used to obtain a new set of amplitudes. These new amplitudes can be approximated in any dynamical theory; they have the advantage that resonances with definite parity frequently decouple from certain amplitudes. This simplifies study of the parity content of duality. The new amplitudes for the reactions $N\bar{N} \rightarrow N\bar{N}$ and $\rho\pi \rightarrow \pi\rho$ are given. Using these amplitudes, a Veneziano-like model is formulated for these reactions with the additional requirement that each trajectory have unique quantum numbers—i.e., no conspiracies are allowed. In $N\bar{N}$, it is found that no π-like trajectories can participate in such a bootstrap. Results for $\rho\pi$ scattering are less striking, but the reduction of number of terms due to parity requirements is easily demonstrated. (auth)

32159 POSSIBLE TEST OF MATTER–ANTIMATTER SEPARATION. Caser, S.; Omnes, R. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Lett.; 39B: No. 3, 369-70(1 May 1972).

The strong-interaction energy shift in the protonium atom is estimated and shown to be a possible test for the existence of a phase transition in the high-energy black-body radiation. (auth)

32160 DUAL RESONANCE MODEL WITH EXOTIC RESONANCES. Hayashi, Mitsuo J. (Osaka City Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 3, 901-7(Mar 1972).

Dual resonance model with exotic resonances for $\pi\pi$, πK, $K\bar{K}$, KK scattering is proposed. It is shown that the exotic resonances are consistent with the "extended nonet mass relation," and the normal mesons still satisfy the approximate nonet scheme. Conjectures are made that the scalar κ-meson spectrum has double peaks and that the tensor f-meson spectrum has double peaks for the rare decay mode $K\bar{K}$. (auth)

32161 LOW ENERGY $\pi\pi$ SCATTERING AND THE VENEZIANO MODEL WITH A SUBTRACTION CONSTANT. Miyake, Shogo (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 47: No. 3, 919-24(Mar 1972).

A simple model for low energy $\pi\pi$ scattering is proposed. It is made up of the Veneziano amplitude with a single satellite term and a non-Veneziano amplitude (non-resonating background or Pomeron term). The $\pi^+\pi^-$ and $\pi^+\pi^0$ total cross sections are calculated at low energies using the amplitudes. The results are consistent with the data. Moreover, the $\pi\pi$ s-wave scattering lengths are estimated. The results are consistent with those of current algebra. It is shown that the contribution from a non-Veneziano amplitude is not negligible even at low energies within the present model. It is also shown that the present model approximately fulfills threshold unitarity. (auth)

32162 DECAY WIDTHS OF MESON RESONANCES BASED ON THE HARMONIC OSCILLATOR QUARK MODEL. Ito, Akihiro (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto); 47: No. 1, 228-36(Jan 1972).

Meson decay widths are derived based on the harmonic oscillator quark model, assuming a nonrelativistic SU(3) invariant Yukawa type quark meson interaction. The agreement with experiment is very good in the low momentum transfer region. The width with the Lorentz contraction effect is also derived in agreement with experiment over almost all the momentum transfer regions. (auth)

Strong (Baryon No. = 1)

32163 (ANL/HEP–7034, pp 1-23) PREDICTIONS OF DUALITY AND ABSORPTIVE CUTS AT HIGH ENERGIES. Blackmon, Maurice L. (Syracuse Univ., N. Y. Dept. of Physics). Apr 1970.

From Symposium on polarization at high energy; Argonne, Ill. (15 Apr 1970).

An attempt is made to show that the best phenomenological description of two-body, hadronic scattering at high energies is given by models that have Regge poles and absorptive-type Regge cuts. Duality predictions and predictions of various models for $\pi N \rightarrow KY$, $\bar{K}N \rightarrow \pi Y$, and other hadrons interactions are given. (L.B.S.)

32164 (ANL/HEP–7034, pp 24-34) FINITE ENERGY SUM RULES, DUALITY DIAGRAMS, AND HYPERON POLARIZATION IN THE REACTION $K^-n \rightarrow \pi^-\Lambda$. Field, R. D. Jr.; Jackson, J. D. (California Univ., Berkeley). Apr 1970.

From Symposium on polarization at high energy; Argonne, Ill. (15 Apr 1970).

A preliminary account of a finite-energy sum rule evaluation of the Regge pole amplitudes in the reaction $K^-n \rightarrow \pi^-\Lambda$ is given. This study was motivated by the failure of duality diagrams to predict the observed nonvanishing lambda polarization for near-forward scattering in $K^-n \rightarrow \pi^-\Lambda$. Using a narrow resonance approximation for the low energy amplitudes, the status of exchange degeneracy of the K^* and K^{**} trajectories is investigated. (auth)

32165 (CNRS-CPT–71/P-410) ABSORPTION AND EXCHANGE DEGENERACY: $\pi N \rightarrow KY$ REACTIONS. Girardi, G. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). Oct 1971. 20p. Dep. NTIS (U. S. Sales Only).

A Regge model with absorption is applied to the analysis of hypercharge exchange relations in order to verify the compatibility of exchange degeneracy with the existence of Regge cuts. The fits made to the experimental data are qualitatively satisfactory. (France)

32166 (ISS-71/20) σ-TERM AND LOW-ENERGY π–N SCATTERING. Altarelli, G.; Cabibbo, N.; Maiani, L. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). 1 Aug 1971. 20p. Dep. NTIS (U. S. Sales Only).

A direct expression is presented of the σ-term in pion nucleon scattering in terms of other low energy parameters. Using listed values for these quantities, one obtains; $\sigma = (80 \pm 30)$ MeV. (auth)

32167 (NP-19295) THE POMERON COUPLING TO THE $\Lambda\pi$ SYSTEM. Note No. 348. Merlani, A.; Violini, G. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 29 Nov 1971. 4p. Dep. NTIS (U. S. Sales Only).

The Harari proposal for the interpretation of the finite energy sum rules duality between Regge poles and resonances, that the Pomeron is dual to the background and the remaining Regge poles to the s-channel resonances, is tested in the case of forward $\Lambda\pi$ scattering. The calculation of the asymptotic $\Lambda\pi$ cross sections shows the validity of the Harari model and the reliability of the extrapolation of the $\Lambda\pi$ scattering amplitude from the analysis of $\bar{K}N$ interactions. (J.F.P.)

32168 (RLO–2041-69) MESON CHARGE EXCHANGE REACTIONS IN A REGGE CUT VAN HOVE MODEL. Holden, J. P.; Robertson, D. C. (Oregon Univ., Eugene. Inst. of Theoretical Science). Jan 1972. 25p. Dep. NTIS.

An analysis of the four-meson charge-exchange reactions ($\pi^-p \rightarrow \pi^0n$, $\pi^-p \rightarrow \eta^0n$, $K^-p \rightarrow \bar{K}^0n$ and $K^+n \rightarrow K^0p$) within the context of our Regge pole-cut model based on the Durand-Van Hove model is presented. Quite good fits to all differential cross sections and polarizations are obtained. Predictions for the KN charge exchange polarizations are also presented. (auth)

32169 K-MESON CHARGE EXCHANGE AND THE FACTORIZATION OF THE COMPLEX POLE EFFECTIVE RESIDUES. Zotov, N. P.; Tarasevich, S. V.; Tsarev, V. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 15: No. 2, 373-7(Feb 1972). (In Russian).

The universality and complex Regge pole factorization is shown not to contradict the experimental data on the charge exchange reactions $\pi^-p \rightarrow \pi^0(\eta)n$ and $KN \rightarrow K^0N$. (auth)

32170 σ TERM IN PION–NUCLEON SCATTERING. Schnitzer, Howard J. (Brandeis Univ., Waltham, Mass. CERN, Geneva). Phys. Rev., D; 5: No. 6, 1482-93(15 Mar 1972).

It is argued that the method of Cheng and Dashen gives a calculation of approximately three times the σ term, rather than the σ term itself. This conclusion is based on a correction derived from a unitarization of the t-channel $\pi\pi$ scattering amplitude, consistent with the constraints of current algebra. A detailed analysis of possible model dependence of the result is included. (auth)

32171 AMBIGUITIES IN K^+p PHASE-SHIFT ANALYSES. Coleman, T. P.; Spearman, T. D. (Trinity Coll., Dublin). Phys. Lett.; 39B: No. 2, 240-4(17 Apr 1972).

The zeros of the K^+p scattering amplitude are determined using phase shifts as input. Solutions obtained by the "shortest path" method are found to give discontinuous zero trajectories. A solution is obtained which satisfies unitarity and gives continuous zero trajectories. (auth)

32172 HIGH ENERGY AMPLITUDES FROM FESR FOR REAL PROCESSES. Hirshfeld, A. C. (Univ., Heidelberg). Phys. Lett.; 39B: No. 2, 233-6(17 Apr 1972).

Assuming that Regge cut effects can be neglected for real amplitudes, finite-energy sum rules are applied to the "real" process $K^- n \rightarrow \pi^- \Lambda$. Exchange-degenerate residues with wrong-signature nonsense zeroes are found. An SU(3) rotation yields the πN charge-exchange amplitudes up to a cut effect in Im F_{++}. (auth)

32173 AMPLITUDE ANALYSIS FROM DECAY CORRELATIONS: APPLICATION TO $\pi^- p \rightarrow K^{*0}\Lambda$ AT 3.9 GeV/c. Abramovich, M.; Irving, A. C.; Martin, A. D.; Michael, C. (CERN, Geneva). Phys. Lett.; 39B: No. 3, 353-7(1 May 1972).

Decay correlation data for $\pi^- p \rightarrow K^*\Lambda$ at 3.9 GeV/c are analyzed to determine the amplitude structure. Combinations of observables invariant under rotations between s and t channel frames are emphasized. (auth)

32174 SU(3) AND THE $\Sigma(1385)\pi$ DECAY MODE OF THE D_{03} RESONANCES. Faiman, D. (CERN, Geneva); Plane, D. E. Phys. Lett.; 39B: No. 3, 358-60(1 May 1972).

By assuming the existence of a second octet with $J^P = \frac{3}{2}^-$ whose couplings are related via $SU(6)_w \times O(3)$ to those of the established $\frac{3}{2}^-$ "nonet", recent measurements on the $\Sigma(1385)\pi$ decay modes of the $D_{03}\bar{K}N$ resonances are reconciled with their other partial widths. The predicted properties of the third as yet unobserved D_{03} state raise important questions regarding the measurement of resonant parameters. (auth)

32175 AMPLITUDE ANALYSIS FOR HYPERCHARGE EXCHANGE REACTIONS. Barger, V.; Martin, A. D. (CERN, Geneva). Phys. Lett.; 39B: No. 3, 379-83(1 May 1972).

The s channel helicity non-flip amplitudes for the line reversed reactions $\pi N \rightarrow K[\Sigma,\Lambda]$ and $\bar{K}N \rightarrow \pi[\Sigma,\Lambda]$ are determined directly from cross section and polarization data at 4 GeV/c. Rigorous bounds are obtained on the magnitudes of the flip amplitudes, whose phases are assumed to be given by an exchange degenerate $K^* - K^{**}$ Regge trajectory. The solution for the non-flip amplitude is unique and shows the following characteristics: (i) Im $K^*(\Delta\lambda = 0)$ has a "cross-over" zero at $t \approx -0.15$ in both Σ and Λ reactions, (ii) Im$K^{**}(\Delta\lambda = 0)$ has an approximate double zero near $t \approx -0.6$ in Σ reactions and a positive minimum there in Λ reactions, (iii) Re $K^*(\Delta\lambda = 0)$ and Re $K^{**}(\Delta\lambda = 0)$ are less peripheral in character than their imaginary counter-part and have similar behavior at $\alpha = 0$ to simple Regge poles. (auth)

32176 POLARIZATION AND UNNATURAL PARITY EXCHANGE IN $K^- p \rightarrow (\omega,\varphi)\Lambda$ AND $\pi^- p \rightarrow K^{*0}\Lambda$. Field, R. D. Jr. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett.; 39B: No. 3, 389-92(1 May 1972).

Newly obtained joint density matrix elements for $K^- p \rightarrow (\omega,\varphi)\Lambda$ and $\pi^- p \rightarrow K^{*0}\Lambda$ are used to isolate three interference terms contributing to the polarization. The data show large interference between natural parity exchanges (K^{**},K^*) and substantial interference between unnatural parity exchanges $(K\text{-}K_A)$. SU(3) is used to compare ω,φ and K^{*0} production. (auth)

32177 ESTIMATE OF σ-TERM FROM OFF-MASS-SHELL VENEZIANO-TYPE AMPLITUDE FOR πN SCATTERING. Chowdhury, A. R.; Banerjee, S. N. (Jadavpur Univ., Calcutta). Lett. Nuovo Cim.; 3: No. 15, 650-2(8 Apr 1972).

An off-mass-shell continuation of the Veneziano amplitude for πN scattering is performed, which yields a satisfactory estimate of the σ_{NN} term. (L.B.S.)

32178 REMARKS ABOUT S-CHANNEL HELICITY AMPLITUDES WITH $n \geq 2$. Schmidt, M. G.; Stamatescu, I. O. (Univ., Heidelberg). Lett. Nuovo Cim.; 3: No. 15, 645-9(8 Apr 1972).

The phenomenological picture of s-channel helicity amplitudes for meson-baryon scattering at high energies near the forward direction is discussed according to Regge and Bessel-function models. It is concluded that the Bessel function picture seems to be an excellent phenomenological mnemonic for the imaginary parts of s-channel $n = 0, 1$ helicity flip amplitudes in case of vector-tensor trajectory exchange. For $n = 0, 1$ the picture can be brought into agreement with a reasonable absorptive Regge model. A constant effective-radius prescription is suggested for $n \geq 2$. (L.B.S.)

32179 ABSORPTION MODEL FOR REACTIONS $\pi + p \rightarrow n\pi + N$. Krawczyk, M. (Univ., Warsaw). Acta Phys. Pol., B3: No. 2, 247-53(Mar-Apr 1972).

The application of the absorption model to many body reactions $\pi + p \rightarrow n\pi + N$, with the group of n pions treated as a quasiparticle, with the variable mass, and spin zero, is presented. Predictions of this model are compared with the experimental data for reactions $\pi^+ + p \rightarrow 5\pi + p$ and $\pi^+ p \rightarrow 6\pi + p$ at laboratory momentum of π^+ 8 GeV/c. It is demonstrated that at a given energy the absorption model can roughly describe many body reactions if the absorption factor of Jackson and Gottfried is used. On the contrary the absorption factor of Dar Weisskopf and Watts leads to a complete disagreement with the data. (auth)

32180 HYPERON POLARIZATION FROM MESON–BARYON REACTIONS IN REGGE MODELS. Fialkowski, K. (Jagellonian Univ., Krakow). Acta Phys. Pol., B3: No. 2, 255-61(Mar-Apr 1972).

The hyperon polarization resulting in high-energy meson-baryon strangeness-exchange processes is discussed. The general predictions of various Regge models are compared with experiment. It is shown that the absorption corrections to the strongly degenerate pair of $K^*(890)$ and $K^{**}(1420)$ trajectories describe correctly the observed polarization. The qualitative predictions for cross sections are also discussed. (auth)

32181 SIMPLE RELATION BETWEEN POLARIZATION AND DIFFERENTIAL CROSS-SECTION. Nakai, T.; Miyamura, O.; Kawaguchi, M. (Osaka Univ., Toyonaka, Japan). Lett. Nuovo Cim.; 3: No. 15, 627-30(8 Apr 1972).

A relation between polarization and differential cross section proposed for nucleon-nucleus elastic scattering in the MeV region (Nucl. Phys. 15, 72(1959)) is applied to high-energy hadronic scattering. A simple semi-classical geometrical model is used to interpret the polarization phenomena. The model is compared with experimental data for K^+p, pp, and pn scattering. (L.B.S.)

32182 STRONG-COUPLING MODEL WITH ISOSPIN-HYPERCHARGE SYMMETRY. Majewski, W. (Inst. of Physics, Warsaw). Acta Phys. Pol., B3: No. 2, 315-24(Mar-Apr 1972).

The static baryon model with the symmetry group $SU(2)_J \otimes SU(2)_I \otimes U(1)_Y$ is investigated in the strong coupling limit. In the algebraic (or—equivalently—in bootstrap) formulation of that model the reduced meson-baryon coupling constants can be found from the sum rules involving the static angular momentum and isospin crossing matrices, both proportional to 6j-symbols. This fact enables one to use the identities between 3nj-symbols of the group SU(2) in order to find two types of solutions for the coupling constants and the isobar states spectrum. (auth)

32183 POMERON EXCHANGE AND DIFFRACTIVE PRODUCTION. Hara, Yasuo (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 47: No. 3, 965-70(Mar 1972).

Helicity independence of the Pomeron coupling is generalized to inelastic processes, and the differential cross sections for the $\pi(N) + N \rightarrow \pi(N) + N^*$ $(I = \frac{1}{2})$ productions are shown to have dips at $t = 0$ unless the N^* is with $J^P = (\frac{1}{2})^+$ or $(\frac{3}{2})^-$. Selection rules for the diffractive production $\pi + N \rightarrow X + N$ are also derived. (auth)

32184 FIXED-POLE EFFECTS ON EXCHANGE-DEGENERATE REGGE RESIDUES AND piN SCATTERING. Itabashi, Kiyomi; Kohsaka, Yasutsugu (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 47: No. 3, 934-46(Mar 1972).

A Regge parametrization proposed in a previous paper is examined extensively for πN scattering and is shown to lead to an overall nice fit to the experimental data. The Regge cuts due to absorption and double-Regge-exchange corrections are included. The proposed parametrization is based on an idea on very strong exchange degeneracy (VSED) with helicity-conserving no-compensation mechanism and on the violation of this primordial VSED scheme by the effects of fixed poles at nonsense wrong signature point. In particular it is shown that the relatively small amount of these fixed-pole effects is sufficient to reproduce all the desired features of πN scattering. (auth)

32185 GEOMETRICAL DUALITY, EFFECTIVE REGGE TRAJECTORY AND THE EQUIVALENT HIGH ENERGY MODELS. Kohsaka, Yasutsugu; Takagi, Fujio (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 47: No. 3, 925-33(Mar 1972).

On the basis of a geometrical picture of duality and an extended version of an effective Regge trajectory, a new Reggeized geometrical model is proposed which is formally equivalent to the conventional Regge pole model with a nonsense wrong signature zero as far as the structure of zeros is concerned. The model combines the advantages of both the conventional Regge pole model and the strong absorption model. In particular, a dip is caused by the nonsense wrong signature zero of the "effective" Regge vector or tensor exchange amplitude with a net s-channel helicity flip ν or equivalently by the zero of the Bessel-like function "$J_\nu(b_r\sqrt{-t})$," where b_r is the impact parameter of the direct channel "effective" peripheral resonances. The main features of the differential cross sections and the polarizations for the processes $\pi^\pm p \rightarrow \pi^\pm p$, $\pi^- p \rightarrow$

$\pi^0 n$ and $\pi^- p \rightarrow \eta n$ are successfully explained by taking $b_r \approx 1$ fm. A plausible theoretical argument on the properties of the "effective" trajectory is also given. (auth)

32186 ISOSPIN DEGENERACY AND VENEZIANO REPRESENTATION IN PION–NUCLEON SCATTERING. Hirose, Kikuji; Kanki, Takeshi (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 1, 184-207(Jan 1972).

It is shown that when the Regge trajectories of πN resonances are rotated to have the universal slope with the centers of rotation being identified with the ground state points on the parent trajectories, they exhibit the isospin degeneracies in a special pattern in which the parent trajectories and even some of the first daughters are not degenerate; no clear evidence is found for the exchange degeneracy. By starting from this pattern of the trajectories, a Veneziano representation is constructed for πN scattering with many beta-function terms giving correlations among leading and nonleading trajectories. Veneziano's subsidiary conditions are assumed in order to get definite signatures in the s- and u-channel trajectories, which state that sums of trajectory functions in the s, t and u channels be equal to integers; the conditions are assumed among the trajectories passing through the nucleon, $\Delta(1236)$, ρ meson, and among those through the nucleon, N(1520; D_{13}) f meson. Because of these conditions, the number of possible beta-function terms are greatly reduced and we take all possible terms. It is found that residues of top-ranking trajectories have rather simple structures due to our isospin degeneracy pattern. Certain correlations among these residues in the s-channel low-energy region are obtained, and definite prediction is obtained for the ρ-pole residue of the $B^{(-)}$ amplitude. The results are in good agreement with experimental data. Good results are also obtained for the forward charge-exchange differential cross sections; terms are present which choose the Gell-Mann mechanism or the Mandelstam–Wang mechanism for the dip. The model, however, gives too large cross sections for large angle and backward scattering. (auth)

32187 POMERON-EXCHANGE AMPLITUDE FOR K^+–p SCATTERING AND EXISTANCE OF Z. Karasuno, Toshiaki; Minami, Shigeo (Osaka City Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 1, 338-9(Jan 1972).

The properties of Pomeron-exchange terms in K^+p scattering are discussed, and it is shown that the existence of exotic resonance Z^* can be predicted even when no conclusion about its existence can be derived from the analysis based on Argand diagrams. (L.B.S.)

32188 NEW INTERPRETATION OF DUALITY AND STRUCTURE OF THE RESONANT AMPLITUDE. Sasaki, Koushy (Kansai Univ., Osaka). Progr. Theor. Phys. (Kyoto); 47: No. 1, 170-83(Jan 1972).

From the requirement of Regge pole duality, the direct-channel resonant amplitude is decomposed into two terms, with and without the signature factor τ. A model is suggested such that the former (the latter) term corresponds to the u-channel (t-channel) Regge amplitude with (without) the signature factor. Thus, the model may be regarded as an extension of the one proposed by Coulter, Ma and Shaw. Furthermore, this model enables the part of the s-channel resonant amplitude that is dual to the u-channel (t-channel) Regge amplitude with (without) the signature factor to be revealed, and exchange degeneracies of the Regge poles in the resonance region to be predicted. On the basis of this model, the energy dependence of backward K^-p cross section at 0.9 ~ 2.5 GeV/c is estimated under the assumption that there is no resonance in the K^+p system. The result is in good agreement with experimental data. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 32465.

32189 (INP–785) CALCULATION OF OPTICAL MODEL PHASE SHIFTS IN BORN APPROXIMATION. Kwiatkowski, Krzysztof (Institute of Nuclear Physics, Krakow (Poland)). Dec 1971. 22p. Dep. NTIS (U. S. Sales Only).

The program EPPB written in ALGOL 60 for the computer ODRA 1204 is used for proton–proton elastic scattering at high energies. The optical model phase shifts and amplitudes are calculated in the Born approximation. (J.F.P.)

32190 EMPIRICAL FORMULA FOR PION AND KAON SPECTRA IN pp-INTERACTIONS. Folomeshkin, V. N. (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 15: No. 2, 383-91(Feb 1972). (In Russian).

An empirical formula is proposed which describes the spectra of pions and kaons produced in pp-interactions in a wide range of angles ($0 \leq \theta \leq 2\pi$) and momenta ($0 \leq p \leq p_{max}$) of the secondary particles. The formula has a form $d\sigma = A\Phi_1\Phi_2\Phi_3\Phi_4 d^3p/E$. A function $\Phi_1 = (1 - F) \exp(-Bp_\perp^2) + F \exp(-Gp_\perp^2)$ describes the dependence of the cross section on the transverse momentum. A function $\Phi_2 = \exp(-p^*/(D\sqrt{s}))$ describes the main dependence of the spectrum on the longitudinal momentum. A cutoff $\Phi_3 = (1 - p^*/p^*_{max})^N$ determines the spectrum behavior at the upper kinematical limit. And finally a multiplier $\Phi_4 = 1 - \exp(-sp^{*2}/T - p_\perp^2/H)$ describes details of the spectrum behavior in the lowest momentum and angle region. (auth)

32191 MODEL OF REGGEIZED ONE PION EXCHANGE AND REACTION $pp \rightarrow pn\pi^+$. Boreskov, K. G.; Kaidalov, A. B.; Lisin, V. I.; Nikolaevskii, E. S.; Ponomarev, L. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 15: No. 2, 361-72(Feb 1972). (In Russian).

A model of Reggeized one pion exchange (OPER) was formulated. The existing experimental data on the reaction $pp \rightarrow pn\pi^+$ are considered with the obtained model. The one parameter characterizing an off-mass-shell behavior of the pion is shown to be able to describe satisfactorily all the characteristics of the process treated in the absolute normalization. It should be noted that the model considered describes well the experimentally observed Treiman–Yang angle asymmetry in the center-of-mass system and also its dependence on the beam energy and momentum transfer from target proton to neutron. (auth)

32192 ANGULAR DISTRIBUTION AND MULTIPLICITY OF PIONIZATION PARTICLES AND THE SCALING LAW. Chaudhary, B.; Malhotra, P. K.; Narayan, D. S. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett.; 39B: No. 2, 245-8(17 Apr 1972).

It is shown that in hadron collisions the single particle angular distribution around 90° in the C.M. system becomes, to a high degree of accuracy a function of the single variable $\cot\theta^*/p^*_{in}$, at all energies where the scaling law is valid. Using this result, it is shown that the experimental angular distributions at 19 GeV/c and 1500 GeV/c imply a definite violation of scaling. Further from the I.S.R. data on the flux of γ-rays at 90° and the angular distributions at 19 GeV/c and 1500 GeV/c, the number of pionization particles are shown to increase as some power of s, in contradiction to the scaling law. (auth)

32193 BARYON EXCHANGE AND SHAPES OF INCLUSIVE SPECTRA. Berger, E. L.; Salin, Ph.; Thomas, G. H. (Argonne National Lab., Ill.). Phys. Lett.; 39B: No. 2, 265-70(17 Apr 1972).

Contributions of baryon exchanges to inclusive single-pion production processes are investigated. It is shown that shapes of distributions in $p_\perp^2$ are reproduced remarkably well by t dependence of simple baryon exchange, but absence of structure at WSNZ positions is noted. Simple Regge models cannot reproduce x (or missing mass) dependence of spectra; to achieve agreement with data, additional modulating functions of x are introduced and discussed. Spin and absolute normalization are treated. (auth)

32194 LONGITUDINAL AND TRANSVERSE MOMENTUM CORRELATION OF THE PROTON SPECTRUM. Hwa, R. C. (Univ. of Oregon, Eugene). Phys. Lett.; 39B: No. 2, 251-4(17 Apr 1972).

The inclusive proton spectrum in the region $0.5 \lesssim x \lesssim 0.9$ is described by a through-going proton recoiling against a high-mass cluster. The longitudinal and transverse momentum correlation can then be explained in terms of a simple Regge formula. Evidence is given for the weakness of the triple-Pomeron coupling. (auth)

32195 EXPERIMENTAL INVESTIGATION OF TWO-PARTICLE CORRELATIONS IN THE REACTION $pp \rightarrow \pi^-\pi^-$ + ANYTHING. Bialas, A. (Jagellonian Univ., Krakow); Fialkowski, K.; Wit, R.; Zalewski, K. Phys. Lett.; 39B: No. 2, 211-13(17 Apr 1972).

The two-body correlations between negative pions in the inclusive process $p + p \rightarrow \pi^- + \pi^-$ + missing mass are studied from the available data on multiplicities and single-particle distributions. It is shown that: a) there are strong correlations imposed by energy and momentum conservation, b) at high energies there is an evidence for positive dynamical correlation between negative pions. (auth)

32196 SEPARABLE MODEL FOR HYPERON–NUCLEON INTERACTIONS. Wycech, S. (Inst. of Nuclear Research, Warsaw). Acta Phys. Pol., B3: No. 2, 307-14(Mar-Apr 1972).

A separable two-channel potential model is used to describe hyperon-nucleon reactions. The parameters of the potential are set to reproduce the low energy sigma (lambda) nucleon scattering, hypernuclear data and the virtual bound state of the sigma and nucleon. (auth)

32197 COHERENT DIFFRACTION GENERATION OF PIONS BY PROTONS ON PHOTOEMULSION NUCLEI. Abduzhamilov, Sh.; Azimov, S. A.; Saidkhanov, N. Sh.; Chudakov, V. M. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz.; 15: No. 2, 300-12 (Feb 1972). (In Russian).

A mechanism of $p + A \rightarrow A(A') + N + n\pi$ reactions and angular correlations in these reactions are investigated. (13 figures, 2 tables) (auth)

32198 MODEL FOR $\rho-\omega$ INTERFERENCE IN COHERENT NUCLEAR 3π PRODUCTION IN THE A_1 REGION. Heckman, P. E.; Margolis, B.; Ross, W. A. (McGill Univ., Montreal). Nuovo Cim.; 9A: No. 1, 85-96(1 May 1972).

A model is proposed for describing $\rho-\omega$ interference in 2π spectra from 3π production by pions on any nuclear target. The processes which produce the interference are π + nucleus $\rightarrow$ A_1 + nucleus (diffraction), $A_1 \rightarrow \pi + \rho$, $\rho \rightarrow 2\pi$, and π + nucleus $\rightarrow$ B + nucleus (ω Regge exchange), $B \rightarrow \pi + \omega$, $\omega \rightarrow 2\pi$ (G-parity violation). The production is taken to come from the diffractive part of production on individual nucleons, and the forward-scattering phase is given by Regge theory. The relative decay phase arg $((\omega \rightarrow 2\pi)/(\rho \rightarrow 2\pi))$, is taken as a parameter to be determined by fitting interference data. Other parameters are fixed by comparison with independent data. One prediction of the model is that the observable interference effect should disappear like $P_L^{-1/2}$ as the beam momentum P_L increases. (auth)

32199 ELEMENTARY PION WITH TRANSVERSE-MOMENTUM CUTOFF. Lusignoli, M. (Univ., Aquila, Italy. Univ., Rome); Srivastava, Y. Phys. Rev. Lett.; 28: No. 20, 1348-51 (15 May 1972).

The puzzle of peaks in π-exchange processes is resolved in terms of an elementary pion with transverse momentum cutoff. In np charge exchange, for instance, this implies keeping both t- and u-channel π exchanges. A quantitative fit is obtained for this process maintaining ρ-A_2 exchange degeneracy. This quality of the fit is in general comparable with (if not better than) the strong-cut model with less than half the number of parameters. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 32442.

32200 (CNRS-CPT-71/P-414) HAMILTONIAN SPECTRUM AND ALGEBRAIC EQUIVALENCE OF QUASI-FREE STATES OF THE FERMION FIELD. Ghez, P. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). Nov 1971. 18p. (In French). Dep. NTIS (U. S. Sales Only).

Connections between the asymptotic ratio set introduced by Araki and Woods for the classification of the factors and spectrum of Tomita's modular operator in representations of the canonical anticommutation relations are studied. (France)

32201 (LNF-71/79) CONFORMAL ALGEBRA IN SPACE–TIME AND OPERATOR PRODUCT EXPANSION. Ferrara, S.; Gatto, R.; Grillo, A. F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 26 Nov 1971. 100p. Dep. NTIS (U. S. Sales Only).

A discussion is given of the conformal group in space–time, broken conformal symmetry, restrictions from conformal covariance on equal-time commutators, manifestly conformal covariant structure of space–time, conformal invariant vacuum expectation values, operator products and conformal invariance on the light cone, and the consequences of exact conformal symmetry on operator product expansions. (J.F.P.)

32202 (LNF-71/83) TENSOR REPRESENTATIONS OF CONFORMAL ALGEBRA AND CONFORMALLY COVARIANT OPERATOR PRODUCT EXPANSION. Ferrara, S.; Gatto, R.; Grillo, A. F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 15 Dec 1971. 41p. Dep. NTIS (U. S. Sales Only).

A conformally covariant formulation of operator product expansion is discussed as an expansion of the product of two representations into a direct sum of irreducible representations. The basic irreducible representations are analyzed and classified. The isomorphism between the conformal algebra and the 0(4,2) algebra is used to obtain a manifestly covariant formalism. The implications of the isomorphism in the derivation of the representations is discussed. The covariant 0(4,2) formalism directly relates dominant terms to nondominant terms in the light-cone limit. The essential coincidence of the problem of a conformal covariant operator product expansion to the problem of determining the form of the three-point function is stressed, together with the relevance of a selection rule for two-point functions following from exact (not spontaneously broken) conformal covariance. The role of Ward identities in a conformal covariant scheme is pointed out, and the mathematical implications on the n-point functions from causality are described. (auth)

32203 (NP-19289) SHADOW OPERATOR FORMALISM FOR CONFORMAL ALGEBRA. VACUUM EXPECTATION VALUES AND OPERATOR PRODUCTS. Note No. 361. Ferrara, S.; Grillo, A. F.; Parisi, G.; Gatto, R. (Rome Univ. (Italy). Istituto di Fisica). 29 Feb 1972. 10p. Dep. NTIS (U. S. Sales Only).

A set of general properties of conformal covariant theories is presented. The formalism is entirely formulated in space-time and the requirement of conformal symmetry is simply achieved by adding to the Poincare algebra plus dilatation of a nonlinear discrete operation. (J.F.P.)

32204 CONSERVED TENSOR CURRENTS, ISOVECTOR PHOTONS, AND THE ALGEBRAIC REALIZATION OF CHIRAL SYMMETRY. I. THE ALGEBRA OF COUPLINGS. Rockmore, Ronald (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., D; 5: No. 6, 1522-31(15 Mar 1972).

Weinberg's program for the algebraic realization of chiral symmetry is considered in an enlarged chiral model obtained by adjoining to the usual SU(2) × SU(2) algebra of currents, isovector and isoscalar tensor currents with equal-time commutation relations given by the quark model. The isovector tensor current is taken to be conserved, thereby permitting the introduction of "isovector photons" into the ordinary model. It is necessary to analyze asymptotically inelastic ($\pi + \alpha \rightarrow \gamma + \beta$, $\pi + \alpha \rightarrow \pi + \gamma + \beta$, $\pi + \alpha \rightarrow \pi + \gamma + \gamma + \beta$) processes as well as elastic ($\pi + \alpha \rightarrow \pi + \beta$, $\gamma + \alpha \rightarrow \gamma + \beta$) processes to close the derived algebra of couplings, which is shown to be that of SU(4). (auth)

Applications (Electromagnetic and Weak)

32205 (NP-19288) SIMPLE AND GENERAL DERIVATION OF CONSISTENT CONTINUOUS PARAMETER SUM RULES. Note No. 350. Czekalski De Achterberg, M.; Ferro Fontan, C.; Violini, G. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 13 Dec 1971. 17p. Dep. NTIS (U. S. Sales Only).

It is shown that generalized continuous parameter dispersion sum rules are always expressible as a series whose coefficients are the usual integer moment finite energy sum rules. Some current examples in the literature are reviewed. The essential equivalence of several kinds of sum rules is tested for the spin-averaged forward Compton amplitude and the results support the conclusion. (auth)

32206 CP VIOLATION. Wolfenstein, L. (Carnegie-Mellon Univ., Pittsburgh). Fields Quanta; 2: No. 4, 375-401(Apr 1972).

In the review of CP violation K^0 decays are considered and also the related questions of the dynamical structure of the weak interaction, the existence of the intermediate boson which mediates the weak interaction, and the existence of an interaction intermediate in strength between the weak and gravitational interactions. (J.F.P.)

32207 BREAKING THE SYMMETRY OF THE BARYONS AND THE MESONS. Li, Ling-fong; Pagels, Heinz (Rockefeller Univ., New York). Phys. Rev., D; 5: No. 6, 1509-21(15 Mar 1972).

An approach to the breaking of SU(3) × SU(3) symmetry is presented which emphasizes the Nambu–Goldstone realization of this symmetry. Here the octet, π, K, η are the ground-state mesons. For matrix elements which are not analytic in the symmetry-breaking parameters, the leading behavior in symmetry breaking can be established exactly. An example of this is a chiral-limit theorem on the meson decay constants $f_K/f_+(0)f_\pi - 1 = [3(m_K^2 - m_\pi^2)/64\pi^2 f_\pi^2] \times \ln [64\pi^2 f_\pi^2/3(m_K + m_\pi)^2] + O(\lambda)$. For matrix elements which are analytic to leading order in symmetry breaking, the hypothesis of threshold dominance of the Goldstone-boson-pair states is advanced. When this hypothesis is applied to the mass splittings of the ground-state mesons there results an eigenvalue problem to which the unique nontrivial solution corresponds to octet enhancement. This is independent of any assumption about the Hamiltonian symmetry breaking. When these ideas are applied to the baryon mass splittings octet solutions corresponding to tadpole-model results and a new result $\frac{3}{10}(f/d)_B = (f/d)_A/[3(f/d)_A^2 - 1]$ relating the baryon mass f/d ratio to the axial-vector–baryon f/d ratio, in good agreement with experiment. Electromagnetic mass shifts are also discussed in this context and it is advocated that for $\Delta I = 1$ mass shifts the Cottingham formula diverges (and should be abandoned). If the Cottingham formula diverges for ΔI = 1 mass shifts, then the Dashen's sum rule $\mu^2_{K^+} - \mu^2_{K^0} = \mu^2_{\pi^+} - \mu^2_{\pi^0}$ no longer holds. An alternative, finite approach for ΔI = 1 mass shifts is suggested and developed. (auth)

Applications (Strong)

32208 (ISS-71/21) SOME FEATURES OF $(3,\bar{3}) \oplus (\bar{3},3)$ BREAKING OF CHIRAL SYMMETRY. Maiani, L. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). 1 Sep 1971. 23p. Dep. NTIS (U. S. Sales Only).

In this lecture some general properties of the $(3,\bar{3}) \oplus (\bar{3},3)$ breaking of chiral SU(3) ⊗ SU(3) are discussed. These include the relations between vacuum breaking and explicit breaking and the elimination of possible ambiguities in the connection of the breaking parameters to experimentally observed quantities. Some recently advanced speculations on the breaking of scale invariance are illustrated. (auth)

32209 (LNF-72/3) NONET STRUCTURE OF THE $J^{PC} = 3^{-2}$ MESONS. Bramon, A.; Greco, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 11 Jan 1972. 14p. Dep. NTIS (U. S. Sales Only).

The meson resonances g(1660), φ_N(1650), φ_N(1830) and K_N(1760) are tentatively grouped in an "ideal" SU(3) nonet having $J^{PC} = 3^{-2}$. A discussion of their masses and their decay modes is presented showing general agreement with the available experimental data. The results are also discussed in the light of finite-energy sum rules for the reactions $\pi k \rightarrow \omega k$ and $\pi k \rightarrow \varphi k$. (auth)

32210 SELECTION RULES AND RATIOS FOR AXIAL COUPLINGS. Buccella, F. (CERN, Geneva); Nicolo, F.; Pugliese, A.; Sorace, E. Nuovo Cim.; 9A: No. 1, 120-31(1 May 1972).

The predictions are studied for the axial couplings following from the use of the mixing operator U(Z), previously introduced to tilt the axial charges of SU_6 in the physical ones. The quantum number $(-1)^{L+L_3}$, where L and L_3 are the O_3 angular momentum and its third component, is shown to be conserved. From the properties of Z further predictions can be achieved as the D/F = $\frac{3}{2}$ for the $\frac{1}{2}^+$ baryon octet in general agreement with experiment. (auth)

Field Theories

General

32211 GENERALIZED INVARIANT VARIATIONAL PROBLEMS. Logan, John David (Univ. of Dayton, Ohio). J. Math. Anal. Appl.; 38: No. 1, 174-86(Apr 1972).

The Noether theorems are extended to include constraining relations on the variations. These relations take the form of linear differential operators and Fredholm-type integral operators acting on a set of fundamental variations. (J.F.P.)

32212 ENERGY OF A STATIONARY SYSTEM IN A GENERAL FIELD THEORY. Hall, G. S. (Univ. of Newcastle-upon-Tyne, Eng.). Acta Phys. Pol., B3: No. 2, 179-87(Mar-Apr 1972).

Tolman's theorem concerning the expression for the energy of a stationary system in general relativity, in terms of the Einstein canonical energy-momentum complex, is extended so as to apply to a general class of field theories. The general result is then criticized and a remedy is given which results quite naturally in an infinite number of different energy-momentum complexes. One of these complexes might reasonably be called "canonical" and for the special case of general relativity, this "canonical" complex turns out to be the one proposed by Moller. (auth)

32213 STATIC SPHERICALLY SYMMETRIC SOLUTION IN BONNOR'S UNIFIED FIELD THEORY. MAGNETIC CASE. Pant, D. N. (Banaras Hindu Univ., India). Progr. Theor. Phys. (Kyoto); 47: No. 3, 1051-2(Mar 1972).

Bonnor's field equations in Einsteins' unified field theory are solved for the spherically symmetric total field in the case of magnetostatic field. (L.B.S.)

32214 FIELD THEORY. I. FIELD DYNAMIC EQUILIBRIUM. Gulak, Yu. K. Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 10, 46-52 (1971). (In Russian).

The possibility of predominantly more stable trajectories of macroparticles is examined, when the initial conditions of their motion in a central field remains indeterminate. The concept of and equations for "field-dynamic" equilibrium are introduced, and one of the possible physical interpretations of this state is elucidated. General considerations relative to a solution of the equation are presented, and a similarity between the equations obtained and the quantum mechanical equations of Schroedinger is noted. (tr-auth)

Quantum Field Theory

Refer also to abstract 32203.

32215 (INP-782) ON THE NEW DIRAC EQUATIONS. Kapuscik, E. (Institute of Nuclear Physics, Krakow (Poland)). Dec 1971. 17p. Dep. NTIS (U. S. Sales Only).

A general class of wave equations is considered which as a special case contains the new wave equations proposed by P.A.M. Dirac. It is shown that it is possible to introduce the interaction with an external electromagnetic field if one chooses different members of the considered class. A particular case of such wave equations is treated in some detail. (auth)

32216 (LNF-72/1) CONFORMAL COVARIANT CORRELATION FUNCTIONS. Ferrara, S.; Parisi, G. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 4 Jan 1972. 12p. Dep. NTIS (U. S. Sales Only).

The general constraints of "full conformal symmetry," on n-point-correlation functions are discussed. An identity for the three-point correlation function is derived from conformal symmetry, which allows one to derive an integral representation for any "irreducible" conformal graph. The connections of these results to conformally covariant "generalized Wilson operator products expansions" are pointed out. Arguments which suggest locality property of a conformal covariant expansion for the n-point functions are discussed. (auth)

32217 (LNF-72/13) CONFORMAL INVARIANCE IN PERTURBATION THEORY. Parisi, G. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 16 Feb 1972. 6p. Dep. NTIS (U. S. Sales Only).

Asymptotic conformal invariance is proved to be true at all orders in perturbation theory. The correct Ward Identities for broken conformal invariance are derived: they are the extension of the Callan Symanzik equation from scale to conformal transformations. (auth)

32218 (NYO-3829-89) PERTURBATION LAGRANGIAN THEORY FOR DIRAC FIELDS: WARD-TAKAHASHI IDENTITY AND CURRENT-ALGEBRA. Lam, Yuk-Ming P. (Pittsburgh Univ., Pa. Dept. of Physics). Feb 1972. Contract AT(30-1)-3829. 19p. Dep. NTIS.

In a class of Lagrangian field theories for Dirac spin-$\frac{1}{2}$ particles, the BPH renormalization scheme provides a proof of the operator forms of Euler-Lagrange equations of motion, Noether's theorem and Ward-Takahashi identities. Time-ordered products for some derivatives of Dirac fields can only be defined with special care in terms of Feynman graphs. Current-algebra Ward-Takahashi identities are obtained if $L^{\text{derivative}}$ is invariant under the algebra; however, Schwinger terms are absent from these identities. (auth)

32219 MULTIPOLE EXPANSIONS OF THE LAMB SHIFT. Granovskii, Ya. I. (Donetsk State Univ., USSR). Yadern. Fiz.; 15: No. 2, 340-4(Feb 1972). (In Russian).

A new method is developed for calculation of the radiative shift of the level based on expansion in series in the angular momentum of the virtual electron. Radial integrals are calculated and mass renormalization is performed. (auth)

32220 QUANTIZATION OF SYSTEMS WITH QUADRATIC DERIVATIVE INTERACTIONS. Hellman, W. S.; Hood, C. G. (Boston Univ.). Phys. Rev., D; 5: No. 6, 1552-5(15 Mar 1972).

Fields described by Lagrangian densities of the form $\partial^\mu \varphi G \partial_\mu \varphi$ are considered. It is found that there is an ordering of operators in such systems which defines a unique Hamiltonian for which consistency between the Euler-Lagrange Heisenberg field equations is obtained. This ordering results in a subtraction term which removes a divergent mass-like term to first order in the one-pion-to-one-pion transition amplitude. (auth)

32221 UNIQUENESS OF THE VACUUM ENERGY DENSITY AND VAN HOVE PHENOMENON IN THE INFINITE-VOLUME LIMIT FOR TWO-DIMENSIONAL SELF-COUPLED BOSE FIELDS. Guerra, Francesco (Princeton Univ., N. J.). Phys. Rev. Lett.; 28: No. 1[illegible] 1213-15(1 May 1972).

For a class of model quantum field theories in two-dimensional space-time describing a neutral scalar boson field interacting in a region of length l, the vacuum energy density converges as $l \rightarrow \infty$. In the same limit the vacuum state approaches zero in the weak sense, as proposed by van Hove. (auth)

32222 BOUND-STATE PROBLEM IN THE ELCTRODYNAMICS OF SPIN-ZERO PARTICLES. Nandy, A. (Univ. of California, Santa Barbara). Phys. Rev., D; 5: No. 6, 1531-7(15 Mar 1972).

The relativistic corrections to the Coulomb binding energies of a system of two spin-zero particles of opposite charge are calculated and compared with the previous results of other authors. The decay of the bound state into two photons is discussed for various angular momentum states and a possible mechanism for production of the bound state is mentioned. (auth)

32223 MASSIVE VECTOR FIELD AND ELECTROMAGNETIC FIELD IN THE LANDAU GAUGE. Nakanishi, Noboru (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 5: No. 6, 1324-30(15 Mar 1972).

It is shown that by introducing an auxiliary scalar field having negative norm, one can formulate a consistent, manifestly covariant, and manifestly renormalizable theory of a neutral vector field. The S matrix is unitary if the vector field couples with a conserved current. An important feature of this theory is that it smoothly tends to quantum electrodynamics in the Landau gauge when the bare mass of the vector field goes to zero. On the basis of this fact, one resolves the drawback of Johnson's proof of the statement that the physical mass of the vector field must vanish when its bare mass vanishes. Furthermore, it is explicitly demonstrated how the vacuum expectation value of the commutator of Heisenberg operators behaves as the mass tends to zero. Finally, an extension of this theory to the massive Yang–Mills field is briefly discussed. (auth)

32224 APPROACH TO DERIVATIVELY COUPLED LAGRANGIAN FIELD THEORIES. Lazarides, G. (Imperial Coll. of Science and Tech., London); Patani, A. A. Phys. Rev., D; 5: No. 6, 1357-66(15 Mar 1972).

A method is developed for treating polynomial and nonpolynomial derivatively coupled Lagrangian field theories on the basis of analytic renormalization. The method resolves the problems encountered previously in these theories and leads to physically acceptable results. In particular, the Adler condition in chiral theories and gauge invariance in gravity-modified electrodynamics is obtained. (auth)

32225 VACUUM POLARIZATION OF GAUGE-INDEPENDENT SPIN-1 FIELD. Shamaly, A.; Capri, A. Z. (Univ. of Alberta, Edmonton). Lett. Nuovo Cim.; 3: No. 15, 637-41(8 Apr 1972).

The vacuum polarization of the minimally coupled causal spin-1 field given by Takahashi and Palmer is calculated and is found to be identical with that of the minimally coupled Proca field. (L.B.S.)

32226 MODERN CONCEPT OF ABSOLUTE IN SPECIAL RELATIVITY. Ayub, S. M. J. Natur. Sci. Math.; 11: No. 1, 13-18(Apr 1971).

A discussion is given of the assumption that the velocity of light is absolute. Various experiments for testing this assumption are proposed, and previous theoretical work is summarized. (J.F.P.)

32227 TEORETICHESKAYA FIZIKA. TOM IV. RELYATIVISTSKAYA KVANTOVAYA TEORIYA. CHAST' 2. (Theoretical Physics. Volume IV. Relativistic Quantum Theory. Part 2). Landau, L. D.; Lifshits, E. M. Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury (1971). 288p.

The theory of radiative corrections is considered in detail, and thus completes the presentation of quantum electrodynamics. The dynamic symmetry of hadrons deals with isomultiplets, hypercharge, metastable hadrons, G-parity, unitary symmetry SU(3), supermultiplets, and superspinor operators. Electromagnetic form factors of hadrons, electron scattering by hadrons, their multipole moments, and some low-energy theorems for bremsstrahlung and photon scattering are considered in hadron electrodynamics. Attention is focused on weak interactions: leptons, muon decay, kinematic muon structure, isotopic properties, β decay of neutrons, and neutral K-mesons. (K.S.W.)

32228 PROBABILISTIC INTERPRETATION IN THE THEORY WITH INDEFINITE METRIC. Yokoyama, Kan-ichi (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 1, 352-3(Jan 1972).

In order to avoid the appearance of negative probability in the theory with indefinite metric, a different approach in the theory of regularization is studied. The approach is essentially based on Bogolyubov's unitarization mechanism, but regularizing fields introduced can be treated as real fields describing physically possible particles without destroying unitarity. (L.B.S.)

32229 CONSISTENCY BETWEEN LAGRANGIAN AND HAMILTONIAN FORMALISMS IN QUANTUM MECHANICS. II. Kimura, Toshiei; Sugano, Reiji (Hiroshima Univ. Osaka City Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 3, 1004-25(Mar 1972).

It is examined whether a consistent quantization can be carried out for a non-linear Lagrangian when one cannot resort to the transformation from the given Lagrangian $L = (1/8)g^{-1/4} \times \{g_{ir}, \dot{q}^r\} g^{1/2} g^{ij} \{q_{js}, \dot{q}^s\} g^{-1/4} - v(q)$ to the standard form $L = 1/2 \dot{Q}^a \dot{Q}^a - V(q)$. In order to obtain the variational equation the commutation relations for δq^i and δq^i are settled so as to be consistent with the Euler–Lagrange equation. Under the premise of $\delta \dot{q}^i = (d/dt)\delta q^i$, it is shown that consistent Lagrangian and Hamiltonian formalisms exist when a space defined by metrics g_{ij} is of constant curvature. All consequences of a previous paper are derived and the dynamical model reduces to the case of flat space, if the commutability between the Euler equation and δq^i is supposed to hold. As a nontrivial example of the irreducible dynamical models, the case of the three-dimensional space with constant curvature is investigated. It is shown that for this model the explicit form of $[\dot{q}^i, \delta g^j]$ and $[\dot{q}^i, \delta \dot{q}^j]$ are all determined and the consistent quantization is carried out. (auth)

32230 GREEN'S FUNCTIONS IN NON-LINEAR FIELD THEORIES. Nishijima, Kazuhiko; Watanabe, Tadashi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 3, 996-1003(Mar 1972).

The functional differential equation obeyed by the generating functional of the time-ordered Green's functions is derived in nonlinear field theories. It is pointed out that the distinction between the T and T* products of field operators is essential in this derivation. It is also shown how to modify the Dyson formula in nonlinear field theories. (auth)

32231 NOTE ON THE INTERACTION REPRESENTATION FOR THE NONLINEAR FIELD OF THE CHIRAL DYNAMICS TYPE. Okabayashi, Takao; Sasaki, Takashi; Yoshikawa, Koji (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 1, 293-303 (Jan 1972).

Starting from the energy operator in the Heisenberg representation which is invariant under an internal group in the sense of the non-linear realization of a group on its subgroup, the Hamiltonian density in the interaction representation is derived by the most elementary method that is convenient to keep the order of operators. Then the integrability condition of the Tomonaga–Schwinger equation is confirmed, and the applicability of Matthew's theorem of the system is discussed. The normal dependent part of the Hamiltonian density is composed of two parts: one is necessary to make the normal independent part integrable, and the other depends on the order of operators in the energy operator. Provided the order of operators in the energy operator is symmetrized, the second part does not come out and Matthew's theorem does hold. The connection of the order of operators and the invariance of the energy operator under the internal group is also discussed. (auth)

32232 COVARIANT AXIAL-VECTOR CURRENT AND ITS DIVERGENCE EQUATION. Kikuchi, Kozo; Yamamoto, Kunio (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 1, 288-92(Jan 1972).

In spinor electrodynamics, it is shown that $i\bar{\psi}(x)\gamma_\mu\gamma_5\psi(x)$ is not a covariant axial-vector. The covariant part of $i\bar{\psi}(x)\gamma_\mu\gamma_5\psi(x)$ satisfies the divergence equation which has the same form as Adler's one and is consistent with the equations of motion. (auth)

32233 CAUSAL PROPAGATION OF INTERACTING R.S. FIELD AND CONSISTENCY IN THE QUANTIZATION. Nagpal, A. K. (Univ. of Delhi). Lett. Nuovo Cim.; 3: No. 17, 698-701(22 Apr 1972).

A consistent quantization scheme for the spin-$3/2$ field was found by Nath et al. (Phys. Rev. D, 3: 1851 (1971)), where the interaction term involves the spin-$3/2$ field only linearly. The expected causal mode of propagation of the spin-$3/2$ classical wave equation in the presence of interaction is investigated by evaluating the characteristic determinant and examining its characteristic roots. It is found that the characteristic surfaces are all tangent to the light cone or the signals are propagated at the velocities of the speed of light. Using Schwinger's action principle of quantization method, it is found that the anticommutation relations are compatible with the positive definite metric. (L.B.S.)

32234 COMPARISON OF DIFFERENT APPROACHES TO RENORMALIZATION. Marinaro, M. (Queen Mary Coll., London. Univ., Naples). Nuovo Cim.; 9A: No. 1, 62-74(1 May 1972).

Starting with the theory of a scalar neutral boson field with $g\varphi^3 + g\varphi$ coupling, the connection between the renormalization obtained through perturbative expansions and that obtained through regularization of the recursive equations for Green's functions is studied. The two approaches give the same renormalization of mass and charges. (auth)

Gravitation and General Relativity

Refer also to abstract 32246.

32235 (EUR-4770) EXPERIMENTAL INVESTIGATION ON THE NEUTRON SPIN PRECESSION IN A GRAVITATIONAL FIELD. Forte, M. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1972. 16p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 40.-.

It has been suggested theoretically that, in the gravitational potential of a particle, spin-dependent terms, violating both P and T invariance, could exist. Related effects have been investigated in recent experiments, which are briefly reviewed. A possible precession of the neutron spin in the earth gravitation field is investigated, by analyzing the change in the polarization components of a slow neutron beam. Original experimental methods are presented and, from the preliminary results, an upper limit is estimated for the gravitational precession frequency of a neutron. (auth)

32236 (NP-19296) THE MECHANICS OF PARTICLES INSIDE A ROTATING CYLINDRICAL MASS SHELL. Note No. 355. Pietronero, L. (Rome Univ. (Italy). Istituto di Fisica). 4 Feb 1972. 19p. Dep. NTIS (U. S. Sales Only).

It is shown that up to the 2nd order in the gravitational constant the effect of a rotating mass shell on a particle moving near its axis is the same as that of a rotating coordinate system. Coriolis force and centrifugal force have, contrary to the case discussed by Thirring, the value expected in a rotating reference frame. (auth)

32237 GRAVITATION THEORY AND OSCILLATING UNIVERSE. Goldman, Itzhak; Rosen, Nathan (Technion-Israel Inst. of Tech., Haifa). Phys. Rev., D; 5: No. 6, 1285-7(15 Mar 1972).

The field equations of a noncovariant theory of gravitation, based on the existence of a preferred frame of reference in the universe, are applied to the homogeneous isotropic cosmological model. One is naturally led to a particular value of the previously undetermined constant present in the equations. The second-order equation determining the radius of the universe can be integrated to give a first-order equation similar to that of general relativity, but with an additional term that can lead to oscillations without any singular state. One obtains a conservation law for the total energy, which is found to be positive definite. (auth)

32238 GENERAL RELATIVITY AS A SOURCE OF DIFFICULTIES IN TIME-SYMMETRIC ELECTRODYNAMICS. Degasperis, A. (Univ., Lecce, Italy). Phys. Rev., D; 5: No. 6, 1247-55(15 Mar 1972).

The mass of a bound state of two charges in time-symmetric electrodynamics is considered as a source of a gravitational field. The prescription of the theory of general relativity leads to serious difficulties such as a dependence of the gravitational mass on the lifetime of the bound state. Similar results are found also in the scalar theory. (auth)

32239 CONSERVATION LAWS AND SYMMETRY PROPERTIES OF SCALAR-TENSOR GRAVITATIONAL THEORIES. Hart, Harold B. (Western Illinois Univ., Macomb). Phys. Rev., D; 5: No. 6, 1256-1262(15 Mar 1972).

Scalar-tensor (ST) analogs of the Einstein pseudotensor, the von Freud superpotential, the Møller superpotential, and the Komar vector are derived and used to form conservation laws appropriate to any version of the ST gravitational theory. When applied to a ST central-mass field, the conservation laws are found to yield correct values for total energy and momentum. The scalar field is shown to affect, in general, not only the form of the conservation laws but, through its symmetry properties, the identification of physically significant conserved quantities. It is pointed out that ST-conserved complexes have units of energy and momentum only in certain versions of the theory (e.g., the Brans-Dicke version). (auth)

32240 GENERAL RELATIVISTIC FLUID SPHERES. V. NONCHARGED STATIC SPHERES OF PERFECT FLUID IN ISOTROPIC COORDINATES. Kuchowicz, B. (Univ., Warsaw). Acta Phys. Pol., B3: No. 2, 209-29(Mar-Apr 1972).

The search for new exact solutions of the gravitational field equations for space filled with matter is pursued in isotropic coordinates. These solutions describe static and spherically symmetric distributions of a non-charged, perfect fluid; they may be applied in a general relativistic treatment of stellar structure. In analogy to the general formal solution of Einstein equations in canonical coordinates which was given by Eq. (8.2) in the first paper of this series (Kuchowicz 1968), another general solution for the present case of isotropic coordinates is obtained. The problem of solving a differential equation resulting from the isotropy of pressure is thus reduced to the much simpler task of performing several integrations. The least number of integrations which must be done if we wish to obtain expressions for the metric functions e^{λ} and e^{ν} amounts to two. Some of the specific solutions of quite a simple form are presented. (auth)

32241 PROBLEM OF NONVANISHING GRAVITATION MASS. Vainshtein, A. I. (Inst. of Nuclear Physics, Novosibirsk, USSR). Phys. Lett.; 39B: No. 3, 393-4(1 May 1972).

The problem of the zero-mass limit in the massive gravitational field theory is considered in the framework of classical equations. Beyond the perturbation theory approach the continuous in mass solution is constructed for the case of central symmetric field by contrast with the perturbation theory one. (auth)

32242 CENTRAL-SYMMETRIC SOLUTIONS OF A CLASS OF GENERALIZED EQUATIONS OF GRAVITATION. Nedyalkov, I. P. (Inst. of Physics, Sofia). Progr. Theor. Phys. (Kyoto); 47: No. 1, 334-5(Jan 1972).

Explicit formulas are derived for the static, central-symmetric solution of a class of generalized equations of gravitation in the Newtonian approximation. (L.B.S.)

32243 ENERGY COMPLEX IN THE GENERAL THEORY OF RELATIVITY. Podichev, V. I.; Zadonskii, G. I. Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 10, 57-62(1971). (In Russian).

In the tetrad formulation of the theory of gravitation an energy complex is proposed which would make it possible to compute unambiguously the energy contained in a given volume, in a given set of coordinates. An analog between the tetrad equations of the gravitational field and the covariant form of the equations of electrodynamics is obtained. As an example, a series of accurate solutions to Einstein's equations was obtained. (tr-auth)

32244 CAN SYNCHROTRON GRAVITATIONAL RADIATION EXIST? Davis, Marc (Joseph Henry Physical Labs., Princeton, N. J.); Ruffini, Remo; Tiomno, Jayme; Zerilli, Frank. Phys. Rev. Lett.; 28: No. 20, 1352-5(15 May 1972).

A complete relativistic analysis for gravitational radiation emitted by a particle in circular orbit around a Schwarzschild black hole is presented in the Regge-Wheeler formalism. For completeness and contrast the electromagnetic and scalar radiation emitted by a suitably charged particle are also analyzed. The three radiation spectra are drastically different. Some important consequences and astrophysical implications are discussed. (auth)

Scattering Theory

32245 (ANL/HEP-7034, pp 35-45) PHENOMENOLOGICAL IMPLICATIONS OF COLLIDING REGGE POLES AND CUTS. Ball, J. S.; Marchesini, G.; Zachariasen, F. (Utah Univ., Salt Lake City. Dept. of Physics). Apr 1970.

From Symposium on polarization at high energy; Argonne, Ill. (15 Apr 1970).

It is pointed out that for the medium energy region, a scattering amplitude containing the pole-cut combination is well parametrized by a complex conjugate Regge pole pair, and that this is true whether or not the actual pair of Regge poles is on the physical or unphysical sheet. The $\pi^-p \to \pi^0n$ interaction is considered as an example, and a fit to the polarization and cross section data is shown. (L.B.S.)

32246 (LBL-759) FOUNDATIONS OF S-MATRIX THEORY. I. THEORY AND MEASUREMENT. Stapp, Henry P. (California Univ., Berkeley. Lawrence Berkeley Lab.). 14 Mar 1972. Contract W-7405-eng-48. 39p. Dep. NTIS.

S-matrix theory is systematically developed from basic principles. The question of measurement and space-time interpretation is dealt with. (auth)

32247 (RLO-1388-627) TWIST RELATION, THIRD FACTORIZATION AND THE GENERAL VERTEX IN A DUAL MULTIPARTICLE THEORY WITH NONLINEAR TRAJECTORIES. Baker, M.; Yu, S. (Washington Univ., Seattle); Coon, D. D. (Pittsburgh Univ., Pa.). [1971]. Contract AT(45-1)-1388. 35p. Dep. NTIS.

The following properties of the dual multiparticle theory with nonlinear trajectories are presented: the twist relation, the unsymmetric general vertex obtained directly from third factorization, and the symmetric general vertex. (auth)

32248 RATIO OF THE REAL PART OF THE SCATTERING AMPLITUDE TO ITS IMAGINARY ONE AT NONZERO MOMENTUM TRANSFER. Arushanov, G. G. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz.; 15: No. 2, 378-82(Feb 1972). (In Russian).

From the unitarity condition and the general character of the angular dependence of elastic scattering differential cross sections at high energies it is shown that the ratio of the real part of the scattering amplitude to its imaginary one may reach large values at nonzero momentum transfer. (auth)

32249 COMPLEX REGGE POLES AND NEW APPROACH TO THE PROBLEM OF ALLOWANCE FOR THE CONTRIBUTIONS OF THE CUTS. Zotov, N. P.; Tsarev, V. A. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 15: No. 2, 67-9(20 Jan 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 2, 99-102(20 Jan 1972).

It is shown that a new approach to the problem of accounting for the cut contribution can be formulated on the basis of complex Regge poles and duality. It is noted that allowance for the cuts in the form of complex Regge poles makes it possible to determine the contribution of the cuts with the aid of sum rules, and in the complex Regge pole model it is easy to satisfy the limitations formulated by Harari in the dual-absorptive scattering theory. (J.F.P.)

32250 EVANESCENT WAVES IN POTENTIAL SCATTERING FROM REGULAR LATTICES. Ali, S. Twareque (Univ. of Rochester, N. Y.); Bace, Marjan; Eberly, Joseph H. Phys. Rev., D; 5: No. 6, 1262-73(15 Mar 1972).

A recently developed approach to scattering by regular structures is applied to an investigation of diffracted evanescent waves. The scattered field is expressed exactly, in the near or far field, by a sum of "plane lattice wave" modes. Attention is directed at the diffraction conditions obeyed by these modes when the scatterer is a finitely thick three-dimensional nonorthogonal (triclinic) lattice of individual scattering centers. (auth)

32251 EXPANSIONS OF THE UNEQUAL-MASS SCATTERING AMPLITUDE IN TERMS OF POINCARE REPRESENTATIONS AND COMPLEX ANGULAR MOMENTUM AT ZERO ENEGY. Szegoe, K.; Toth, K. (Central Research Inst. for Physics, Budapest). Phys. Rev., D; 5: No. 6, 1297-1307(15 Mar 1972).

The expansion of the unequal-mass scattering amplitude in terms of Poincaré-group representations was considered for positive and zero values of s, the squared total four-momentum. The usual singularity problem at s = 0 was avoidable, but it turned out that the relevant variable is not j, the total angular momentum, but a quantity nonsingularly related to the Poincaré-invariant $W_\mu W^\mu$ even at s = 0. The notion of complex angular momentum and signature was reexamined, and some modification of the old formalism seemed useful. The results are perfectly compatible with dispersion relations and with the requirements of Regge behavior. In an appendix a theorem is proved for the expansion of a class of functions which are not square-integrable, but have Regge behavior with respect to unitary E(2) representations (that is, for Fourier–Bessel expansions). (auth)

32252 VARIATIONAL PRINCIPLES FOR THREE-BODY BREAKUP SCATTERING. Lieber, M (Univ. of Arkansas, Fayetteville. New York Univ., N. Y.); Rosenberg, Leonard; Spruch, Larry. Phys. Rev., D; 5: No. 6, 1347-56(15 Mar 1972).

A Kohn-type variational principle was previously derived for the scattering amplitude for the breakup of a bound pair by an incident third particle. An alternative derivation is presented. The new derivation, based on the Faddeev equations, though rather formal, is rigorous; the preceding derivation was not. This procedure sheds some light on the manipulations in the earlier derivation. An "adjoint" Kohn-type variational principle is also derived in which the operator H–E acts on the final-state wave function. The "adjoint" result has some convergence difficulties but these have been overcome by techniques described. Finally, a Schwinger-type variational principle is derived and its connection with the recently proposed variational principle of Pieper, Schlessinger, and Wright is discussed. (auth)

32253 KOHN-TYPE VARIATIONAL PRINCIPLE FOR THREE-BODY BREAKUP PROCESSES. Lieber, M.; Rosenberg, Leonard; Spruch, Larry (New York Univ., N. Y.). Phys. Rev., D; 5: No. 6, 1330-46(15 Mar 1972).

A Kohn-type variational principle normally requires knowledge of the asymptotic form of the time-reversed final-state wave function. For the breakup collision of a bound pair of particles by a third particle, the time-reversed final state is a state in which three free particles are incident, and the asymptotic form of the associated wave function is only incompletely understood. A Kohn-type variational principle was obtained for the breakup scattering amplitude (for short-range potentials). The final expression involves only well-defined integrals, though in the course of the derivation finite integrals were separated into separately divergent components. These divergences, which also occur elsewhere in scattering theory, are handled by a redefinition of the integrals which is the analog for integrals of Cesàro summation. (auth)

32254 COMMENT ON THE EXTERIOR–INTERIOR SEPARATION IN THE THREE-BODY PROBLEM. Noyes, H. Pierre (Stanford Univ., Calif.). Phys. Rev., D; 5: No. 6, 1547-51(15 Mar 1972).

The exterior-interior separation of the three-body wave function is derived directly from the Faddeev equations by using the Kowalski representation for the two-body t matrices. The formalism clarifies the relationship between the quantum-mechanical observables in three-body breakup experiments and the two- and three-body wave functions in the interior regions. A complete parametrization of three-body breakup amplitudes suggested by this approach provides the generalization of the Watson–Migdal formula to include interference between resonances in different two-body channels. (auth)

32255 K-MATRIX FORMALISM FOR THE THREE-BODY PROBLEM AND EXTENSION OF THE GLAUBER EIKONAL THEORY. Manning, Irwin (Naval Research Lab., Washington, D. C.). Phys. Rev., D; 5: No. 6, 1472-5(15 Mar 1972).

For the three-body problem, a consistent set of Heitler equations are obtained which connect, for the various channels, the K matrices with the corresponding T matrices. Heitler equations are also obtained relating the corresponding Faddeev equations. The impulse approximation is then applied to the K matrices; the generalized Heitler equations permit the resulting T matrices to be evaluated. The result for the direct channel is that of Glauber's eikonal theory applied to the three-body problem, but now generalized to include the case where the target particles have finite mass. Corresponding to the other channels, Glauber additivity formulas are obtained for rearrangement and breakup collisions, again for unrestricted particle masses. (auth)

32256 GENERALIZED PARTIAL-WAVE DISPERSION RELATION AND THE N/D METHOD. Chen, Chih Kwan (Univ. of California, Berkeley). Phys. Rev., D; 5: No. 6, 1464-71(15 Mar 1972).

It is shown that a meaningful dispersion relation and associated N/D integral equations can be formulated for any partial-wave amplitude, even though the ordinary partial-wave dispersion relation with a finite number of subtractions is violated by models like that of Veneziano. It is also shown that the arbitrary cutoff of the N/D method, which is often introduced to represent the high-energy behavior of the input "potential," can be eliminated in some models (including that of Veneziano) in terms of Regge parameters. (auth)

32257 THEORETICAL DIFFICULTIES WITH THE REGGE–EIKONAL MODEL. Swift, Arthur R. (Univ. of Massachusetts, Amherst). Phys. Rev., D; 5: No. 6, 1400-12(15 Mar 1972).

Dynamical models are used to discuss the theoretical justification of the Regge-eikonal formula for scattering amplitudes. A generalized ladder-diagram model with Reggeon exchange replacing single-particle exchange yields the eikonal result only if the Reggeon amplitude has no mass-shell dependence, since the intermediate-state particles are far from their mass shells at high energy. This result is contrasted with a nonperturbative model of a Regge-pole amplitude which has strong mass-shell dependence. Next, a theory in which the coupling of the Reggeons to the external particles is nonplanar is examined. The double-Reggeon-exchange amplitude does not satisfy the eikonal representation. The perturbation-theory model of Cicuta and Sugar is shown to break down if higher-order corrections to the residue function are calculated. It is concluded that there does not exist any theoretical justification for considering the Regge-eikonal model to be a valid description of high-energy scattering. (auth)

32258 TRIPLE-REGGE AMPLITUDE. Iwasaki, Y. (Kyoto Univ.); Yazaki, S. Phys. Lett.; 39B: No. 3, 361-4(1 May 1972).

The tri-Regge amplitude is found to be composed of two parts; one has the ordinary triple-Regge behaviour, with a factor, in general, which is a generalization of the nonsense-zeroes, and the other has single-Regge behavior. (auth)

32259 PROBLEM OF EXISTENCE OF A SCATTERING S MATRIX. III. Rayski, J. (Jagellonian Univ., Kraków). Acta Phys. Pol., B3: No. 2, 189-93(Mar-Apr 1972).

Instead of describing the scattering processes in terms of asymptotic fields at minus infinity and plus infinity in time, they are expressed in terms of ingoing and outgoing (concentric and excentric) waves from and to infinity in space. This involves a quite different boundary problem as compared to the traditional initial-condition-problem. The system consisting of fields streaming in (out) from (to) spatial infinity is not a well isolated physical system, hence a description in terms of a state obeying a Schrödinger equation is not applicable. The scattering problem is soluble in the Heisenberg picture whereby the necessary boundary information concerns the ingoing fields crossing the surface of the domain. This type of information is subject to an uncertainty relation between energy and time. (auth)

32260 POTENTIALS WITH SUPPRESSED S-WAVE PHASE SHIFT AT LOW ENERGIES. Ferreira, Erasmo (Pontifica Univ. Catolica, Rio de Janerio); Sesma, Javier Progr. Theor. Phys. (Kyoto); 47: No. 1, 165-9(Jan 1972).

It is shown that for a certain class of velocity dependent potentials, the s-wave phase shifts are suppressed at low energies. Instead of presenting the usual linear dependence, these phase shifts behave like the fifth power of the momentum. (auth)

32261 MULTI-REGGEON VERTEX. Hori, Shoichi (Kanazawa Univ., Japan). Progr. Theor. Phys. (Kyoto); 47: No. 1, 272-9(Jan 1972).

Expressions for the multi-reggeon vertex, obtained by means of the multiple-factorization technique, are examined and their connection with one derived by Lovelace with recourse to the mathematical induction is explicitly demonstrated. (auth)

32262 APPROACH TO REGGE BEHAVIOR AND DUALITY BASED ON AN INFINITE SUM OF ONE-PARTICLE-EXCHANGE AMPLITUDES. Kinoshita, Kisei (Kyushu Univ., Fukuoka); Kobayashi, Masanori; Shiga, Kunio. Progr. Theor. Phys. (Kyoto); 47: No. 1, 208-27(Jan 1972).

The implication of Regge asymptotic behavior is studied on the basis of an infinite sum of one-particle-exchange (IOPE) amplitude, which provides a wide framework including various versions of dual amplitudes. The imaginary part of Regge-behaved amplitude comes from the s-u crossing term of the convergent IOPE amplitude, accompanied with the divergence of IOPE expression. Duality between t-poles and u- or s-singularities is necessarily contained in Regge behavior. A general expression for the IOPE amplitude satisfying full Regge behavior is pursued and comments on related models are made in connection with our approach. Phenomenological aspects of various solutions are also discussed. (auth)

32263 OMNES EQUATION WITH BOUND-STATE POLES. Alberi, G. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy); Mosconi, B.; Soper, P. J. R. Nuovo Cim.; 9A: No. 1, 107-19(1 May 1972).

The solution of Omnès' equation in the presence of n bound-state poles is studied. It is found that a set of n sum rules connecting the residua at the poles with the other singularities of the amplitude must be satisfied. A method for using these sum rules to determine the approximate contribution of some dynamic singularities is suggested. An application to the deuteron-disintegration process is compared numerically with a corresponding potential calculation. (auth)

32264 KINEMATICAL SINGULARITIES. II. Minguzzi, A. (Univ., Modena, Italy); Leo, R. A.; Soliani, G. Nuovo Cim.; 9A: No. 1, 37-42(1 May 1972).

Decompositions of the amplitude of some processes involving particles with spin are studied, whose invariant functions have no kinematical singularity in the energy at fixed momentum transfer. (auth)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

Refer also to abstract 31823.

32265 NEUTRAL EXCITATIONS IN He II. Chernikova, D. M. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 3, 1206-16(Mar 1972). (In Russian).

The possibility of the existence of stable optical excitations, such as excitons, in He II is discussed. The decay spectrum of such an exciton is investigated for the model of an imperfect Bose gas. Some peculiarities of the dielectric constant of liquid helium in the ultraviolet region are noted. Estimations of the spectral line widths are made in connection with the recent appearance of some new experimental data. (auth)

32266 QUANTUM-MECHANICAL FORMATION OF VORTICES IN A SUPERFLUID LIQUID. Volovik, G. E. (Inst. of Theoretical Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 15: No. 2, 81-3(20 Jan 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 2, 116-20(20 Jan 1972).

The formation of vortices in a superfluid liquid that moves relative to the vessel walls is considered at T = 0. Inhomogeneities are considered having a characteristic dimension $R \gg a$, where a is the radius of the vortex core and is of the order of atomic dimensions. This makes it possible to use a hydrodynamic description. For convenience, an inhomogeneity is assumed in the form of a hemisphere of radius R on a flat vessel wall, over which liquid flows with velocity at infinity. The probability is sought of formation of a vortex in the form of a half-ring whose ends glide freely over the wall. It is concluded that the inhomogeneity shape most favorable for vortex formation is that of half a flat disk. (M.H.R.)

32267 THEORY OF VORTEX-WAVE CREATION IN ROTATING He II. Iguchi, Ienari (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 1, 45-61(Jan 1972).

The problem of vortex-wave creation by a trapped ion in rotating liquid helium is formulated under the presence of both a dc and an ac field. The analysis is based on classical hydrodynamics, and a truncated Fourier expansion is used to obtain a solution valid for long wavelengths whose wave numbers correspond to the frequency region $\omega \lesssim 10^{10}$ rad/sec. The calculated power loss is small, but nevertheless it may possibly appear as a change of Q in the cavity. (auth)

32268 LATTICE MODEL FOR QUANTUM LIQUID MIXTURES. Takagi, Shin (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 1, 22-36(Jan 1972).

A lattice model is proposed in order to investigate the superfluid phase transition and the phase separation in liquid mixtures of ^3He and ^4He. The Matsubara–Matsuda model for pure liquid ^4He is generalized. An effective Hamiltonian is expressed in terms of spin operators with the magnitude unity. It is solved with the aid of molecular field approximation. A phase diagram thus constructed reproduces characteristic features of liquid ^3He–^4He mixtures. Namely, the lambda line, the critical point of the phase separation and the stratification curves are obtained in good agreement with experiments. In addition, it is shown in a unified manner that the lambda temperatures exhibit a qualitatively correct dependence on ^3He concentration and pressure. (auth)

Superconductivity

32269 (ISS–71/19) SURFACE EXCITATIONS OF TYPE-I SUPERCONDUCTORS IN A STATIC MAGNETIC FIELD. Rogani, A.; Tabet, E. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). 28 Jul 1971. 23p. Dep. NTIS (U. S. Sales Only).

Surface excitations of type-I superconductors in a static magnetic field are studied assuming diffuse scattering at the superconductor surface. The energy spectrum and the density of states for these excitations are obtained using the self-consistent field approach. Some remarks are made about the relevance of the surface states for the microwave impedance evaluation. (auth)

32270 (JINR–P8-6260) ON EXPERIMENTAL DETERMINATION OF THE TRUE VALUE p_f OF TYPE-II SUPERCONDUCTORS. Goncharov, I. N.; Dorofeev, G. L.; Petrova, L. V.; Khukhareva, I. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 21p. (In Russian). Dep. NTIS (U.S. Sales Only).

In an experimental study of the resistance states of the Type-II superconductors it was observed that presence of a sufficiently extended linear range in the volt–ampere characteristic in some cases does not prove the negligibly small effect of the heating of a sample because of the power released in it. This fact is proved by a strong dependence of the measured values $R_f = dV/dI$ on the medium surrounding the sample (He II, He I helium pairs). The calculation is performed taking into account the sample overheating with respect to the helium bath. Based on this calculation, peculiarities of the volt–ampere characteristics are explained, and an attempt is made to determine the true value of the differential resistance corresponding to the helium bath temperature. (auth)

32271 (NP–19235) G-L BEHAVIOUR OF TWO DIMENSIONAL Al FILMS BELOW T_c. Note No. 305. Cerdonio, M.; Di Leo, T.; Lucano, G. (Rome Univ. (Italy). Istituto di Fisica. Instituto Nazionale di Fisica Nucleare, Rome (Italy)). 25 Feb 1971. 7p. Dep NTIS (U.S. Sales Only).

The temperature dependence of fluxoid and of critical current was measured very near T_c for thin Al hollow cylinders using sensitive flux trapping techniques; remarkable agreement with Ginzburg–Landau theory is found despite two-dimensional experimental conditions. (auth)

32272 SUPERCONDUCTIVITY IN α- AND ω-ZIRCONIUM UNDER HIGH PRESSURE. Eichler, A.; Gey, W. (Univ., Karlsruhe, Ger.). Z. Phys.; 251: No. 4, 321-32(1972).

The pressure dependence of the superconducting transition temperature $T_c(p)$ of α-Zr was investigated in both solid and liquid pressure transmitting media. Up to about 45 kbar dT_c/dp was measured to be $+3.5 \times 10^{-6}$ K/bar. Cold working at 4.2 K produced a strong irreversible effect on T_c. The superconductivity of the high-pressure phase, ω-Zr, was studied in its region of stability, i.e., above 60 kbar. For ω-Zr, $dT_c/dp = +7.7 \times 10^{-6}$ K/bar, and $T_c(0) = 0.72$ K (by extrapolation). (auth)

32273 UNIFIED THEORY OF BOSE–EINSTEIN AND FERMI–DIRAC SYSTEMS SUPPORTING NORMAL SUPERFLUID AND SUPERCONDUCTING COMPONENTS. Petrakopoulos, Nikitas Leonida. New York, N. Y.; New York Univ. (1971). 124p. University Microfilms Order No. 72-13,394.

Thesis.

A well-motivated approximation to the second-quantized wave operators $\hat{\psi}^+$, $\hat{\psi}$ and Berezin's formulation of the method of second-quantization are used to generalize a number of Berezin's Theorems so that they are applicable to quantum statistical mechanics. Therefore, an exact unified theory of many-body systems, governed by a special brand of a reduced Hamiltonian, which can support both normal and superfluid components is obtained. An alternative but less-general theory, based on the Friedrichs–Berezin theorems, is also developed. A configuration representation is maintained, and at no point is there a transformation to the well-known momentum space expansions. (Diss. Abstr. Int., B)

32274 PENETRATION DEPTH AND FLUX CREEP IN THIN SUPERCONDUCTING INDIUM FILMS. Anderson, Robert Alan. Urbana, Ill.; Univ. of Illinois (1971). 197p. University Microfilms Order No. 72-12,068.

Thesis.

The ratio $\Delta H_1/\Delta H_0$ of the magnetic field penetrating into the interior region of a hollow thin film cylinder of superconducting indium to the externally applied axial magnetic field was measured using a superconducting magnetometer. Thicknesses of the five samples for which data were taken were between 67 and 160 Å. The temperature range over which the magnetic field penetration measurements were made was about 1.3°K to the critical temperature, near 4.0°K. From those measurements, the value of the London penetration depth at absolute zero was calculated to be 395 Å ± 20 Å, a value larger than for bulk indium, in accordance with other evidence. Except for one of the samples and for temperatures within about 0.3°K of the critical temperature, the data were fitted moderately well by the theoretical temperature dependence. Hysteresis loops resulting from applied magnetic field signals of large amplitude were observed, and several properties of the hysteresis loops that depended on signal amplitude and temperature were measured. Also, flux creep depending logarithmically on elapsed time was observed. The temperature dependence of the logarithmic flux creep rate was shown to be similar to that of the product of the critical current, the temperature, and the square of the penetration depth. (Diss. Abstr. Int., B)

32275 PHOTOELECTRIC OBSERVATION OF THE SUPERCONDUCTING ENERGY GAP IN LEAD. Kunz, Louis William. Stanford, Calif.; Stanford Univ. (1971). 96p. University Microfilms Order No. 72-11,592.

Thesis.

The temperature dependence of the photocurrent from a thin lead film was measured between the temperatures 2.5 and 12K. The technique employed was to cycle the temperature of the lead film between two values at a frequency of 12.3 Hz and measure the change in photocurrent by synchronous detection techniques. A noticeable difference in the temperature dependence between the normal and superconducting states was observed. It is believed that this is due to the presence of the superconducting energy gap Δ. The temperature dependence is in reasonable agreement with the BCS based theory of V. V. Slezov, if a likely spread in transition temperature T_c over the surface of the film is assumed. Comparing experiment and theory on the basis of temperature dependence alone, a rough value for Δ_0/kT_c between 2 and 3 is obtained. This is consistent with the infrared absorption and tunneling measurements of other observers. The size of the change in photocurrent in going from one temperature to another, however, is more than an order of magnitude larger than the change predicted by Slezov's theory. This large discrepancy is presently not understood. (Diss. Abstr. Int., B)

32276 ELECTRONIC THERMAL CONDUCTIVITY OF SUPERCONDUCTING THIN FILMS CONTAINING PARAMAGNETIC IMPURITIES. Bjerkaas, Allan Wayne. Urbana, Ill.; Univ. of Illinois (1971). 114p. University Microfilms Order No. 72-12,090.

Thesis.

The electronic thermal conductivity of thin films of superconducting indium and indium–manganese alloys was measured at temperatures from 1.2 to 4.2 K. The films contained 0.0 to 0.0334 at.% manganese. They were quench-condensed on a Kapton-H film substrate at 4 K, and were kept below 5 K throughout the measurements. The superconducting transition temperature T_c of each thin film was also measured. The ratio K_s/K_n of the thermal conductivity in the superconducting state to that in the normal state was determined as a function of the reduced temperature T/T_c for each film. The results were found to be in disagreement with the theory of Ambegaokar and Griffin. The reduced thermal conductivity K_s/K_n and the transition temperature results are compared with other experiments and with theories which take into account the effects of impurity spin ordering in superconductors. (Diss. Abstr. Int., B)

32277 EFFECT OF CHANGES IN TOPOLOGY OF THE FERMI SURFACE ON SUPERCONDUCTING PROPERTIES. Bar'yakhtar, V. G.; Gann, V. V.; Makarov, V. I.; Ignat'eva, T. A. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 62: No. 3, 1118-30(Mar 1972). (In Russian).

The dependence of the superconducting transition temperature T_c on Fermi energy ϵ_F is investigated for values $\epsilon_F \approx \epsilon_k$ for which changes in the Fermi surface occur. Variation of the superconducting transition temperature on variation of the Fermi energy is found for the case of a smooth dependence of the effective electron–electron attraction amplitude on energy. The dependences of T_c and $\partial T_c/\partial \epsilon_F$ on ϵ_F are tabulated for two cases, for the BCS and Froehlich models. The calculated curves are compared with the experimental data on the dependence of T_c and $\partial T_c/\partial P$ on pressure P for rhenium. The relative change in the density of states during the topological transition is then derived. The effect of electron state density singularities on tunnel characteristics of superconductors is analyzed. The effect of variation of topology of the Fermi surface on the temperature dependence of the thermal expansion coefficient of a metal in the normal state is considered. It is shown that, for $\epsilon_F \rightarrow \epsilon_k$, the linear dependence of the anomalous part of the thermal expansion coefficient on temperature changes into a root dependence. (auth)

32278 RESONANT ULTRASONIC ABSORPTION BY THE NUCLEI OF SUPERCONDUCTORS IN INTERMEDIATE STATE. Khabibullin, B. M. (Physical-Technical Inst., Kazan). pp 887-8 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

Two new possible mechanisms of resonant ultrasonic energy absorption by nuclear quadrupole levels in superconductive metal in the intermediate state are studied. Absorption factors of 10^{-10} cm^{-1} and 5×10^{-8} cm^{-1} are estimated. (D.L.C.)

32279 HIGH-TEMPERATURE SUPERCONDUCTIVITY IN BRIDGE AND LAYER COMPOUNDS. Phillips, J. C. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 28: No. 18, 1196-8(1 May 1972).

A microscopic model is presented for the structure and superconductivity of $A_xT_{1+y}C_2$ compounds, where A is a monovalent atom or radical, T is an even-valence transition metal, C is a chalcogenide, and the parameters x and y lie in the ranges $0.1 < x \lesssim 0.3$, $0 \leq y \lesssim 0.5$. The model explains why the maximum superconducting transition temperature T_S^{max} is higher than 12°K in bridge compounds with $y = 0.1$, although the maximum value of T_S observed in related layer compounds with $y = 0.0$ is about 6°K. (auth)

32280 STUDY OF TWO-DIMENSIONAL MIXED STATE OF TYPE-I SUPERCONDUCTORS. Landau, I. L.; Sharvin, Yu. V. (Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.); 15: No. 2, 59-61(20 Jan 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 2, 88-90(20 Jan 1972).

In the experiments described conditions were realized under which a cylindrical layer of a mixed state could be produced not only on the inner or outer surface of the cylindrical sample, but also inside the sample at an arbitrary distance from the axis. The sample was a hollow indium single-crystal cylinder. A lead wire was placed in the sample cavity and was made to carry a constant current I_b from a superconducting transformer. The current I_0 in the sample was excited by a superconducting generator. All the current leads near the sample were axially symmetrical. Toroidal magnetic-field pickups with permalloy cores were used to measure the currents. The voltage drop across the sample was determined at different values of I_0 and I_b, using a superconducting modulator for this purpose. In addition, coils of copper wire, in the form of flat single layer spirals, were placed flush against the inside and outside surfaces of the samples and served to reveal the change of the sample surface impedance at frequencies on the order of 10^6 Hz upon occurrence of the two-dimensional mixed state on the sample surface. It is shown that layers of the two-dimensional mixed state can exist in doubly connected samples of type-I superconductors. (M.H.R.)

32281 UPPER CRITICAL FIELD OF SUPERCONDUCTING ALLOYS. Nagashima, Tomitaro (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 47: No. 1, 37-44(Jan 1972).

A four-term Kubic expression for the upper critical field H_{c2} is obtained for a dirty superconductor at all temperatures. The result is discussed with reference to the recent experimental observations of Williamson (Phys. Rev., B2: 3545(1970)) on Nb and V alloys. (auth)

32282 SECOND CRITICAL CURRENT OF BULKY SUPERCONDUCTORS. Andreev, A. F. (Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.); 10: No. 9, 291-4 (5 Nov 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 10: No. 9, 453-7(5 Nov 1969).

There should exist a second critical current I_{c2} such that when $I > I_{c2}$ the sample becomes fully normal. Here the critical current I_{c2} is calculated at temperatures close to the superconducting-transition critical temperature of bulky pure Type-I superconductors. To determine I_{c2}, the contribution made to the conductivity of a normal metal by fluctuations of the superconducting order parameter ψ is calculated, with allowance for the magnetic field of the current. (M.H.R.)

32283 RESONANCE IN SUPERCONDUCTORS. Azbel, M. Ya. (Inst. of Theoretical Phys., Moscow). JETP Lett. (USSR) (Engl. Transl.)· 10: No. 9, 277-80(5 Nov 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 10: No. 9, 423-7(5 Nov 1969).

It is shown that in superconductors there can exist a new type of bound state due to a self-consistent interaction of excitations via a magnetic field, H, and not present in normal metals. In this case a band consisting of local levels is adjacent to the continuous spectrum. Its width is of the order of the interaction constant, which is proportional to H^2. The presence of such a spectrum leads to a resonance. (M.H.R.)

32284 SVERKHPROVODYASHCHIE SPLAVY SISTEMY NIOBII–TITAN–TSIRKONII–GAFNII. (Superconducting Alloys in the Niobium–Titanium–Zirconium–Hafnium System). Ivanov, O. S.; Raevskii, I. I.; Stepanov, N. V. Moscow; Izdatel'stvo Nauka (1971). 167p.

Considerable data in the system Nb–Ti–Zr–Hf are summarized, including phase diagrams and superconducting properties for binary, ternary, and quaternary systems. Technological and mechanical properties of such alloys are discussed: forging, rolling, and drawing, and the durability, strength, and ductility of three- and four-component alloys. (84 diagrams; 157 references). (K.S.W.)

32285 IMPURITY BANDS IN SUPERCONDUCTORS WITH MAGNETIC IMPURITIES. Zittartz, J. (Univ., Cologne); Bringer, A.; Mueller-Hartmann, E. Solid State Commun.; 10: No. 6, 513-16(15 Mar 1972).

Impurity bands in superconductors with magnetic impurities are discussed and calculated. It is shown how their existence is related to the Kondo effect. (auth)

32286 EFFECT OF ORDER PARAMETER FLUCTUATIONS ON THE SPECIFIC HEAT OF SUPERCONDUCTOR FILMS. Gunther, L. (Tufts Univ., Medford, Mass.); Gruenberg, L. W. Solid State Commun.; 10: No. 6, 567-70(15 Mar 1972).

The effect of fluctuations of the order parameter on the specific heat of one, two, and three dimensional superconductors is studied using a Hartree approximation in the free energy functional. In all three dimensions, as the temperature is lowered the specific heat rises continuously to a peak value of the bulk discontinuity in the absence of fluctuations. The results are compared with recent specific heat data on superconductor films. While a two-parameter fit yields excellent agreement with experiment, the experimental width of the transition decreases (rather than increases as theory indicates) with the resistance per square $R_{\square}$. (auth)

32287 PHASE TRANSITIONS IN MULTIPLY CONNECTED SUPERCONDUCTORS. Fillmore, Keith Geddes. Vancouver, B. C.; Univ. of British Columbia (1971). National Library of Canada, Ottawa.

Thesis.

Derivation of the Ginzburg–Landau macroscopic equations and their application to the determination of the critical fields and temperatures for superconducting–normal phase transitions in simply connected bodies are reviewed. Second-order phase-transition criteria are obtained in the form of volume integrals that do not require prior solution of the field equations. With the G–L effective wave function ψ in the London gauge for doubly connected bodies, several equivalent expressions for the electromagnetic free energy F_H that do not assume uniform $|\psi|$ are obtained. One of these leads to a systematic method for expanding F_H in powers of $z \equiv |\psi|^2$ and this method is applied to the long hollow circular cylinder. The expansion obtained is used to determine second-order transition criteria for all possible fluxoid states. A closed expression for F_H in the hollow cylinder which does not assume uniform $|\psi|$ is obtained. A detailed analysis of the thin hollow cylinder yields curves for the equilibrium values of free energy, super electron density, magnetic moment, and super electron momentum as functions of a general field variable. Critical points on the curves are identified and the loci of critical points traced as the geometric parameter varies. These functions are extended to surfaces of the variables of field and temperature. Phase transition criteria are obtained for increasing temperature at constant field. Reversible and irreversible curves are obtained describing the variation and destruction of persistent currents at varying temperature, and the results are compared with experiment. The full range of possible fluxoid states is determined, and it is shown that the families of curves obtained for low-fluxoid states may be applied to high-fluxoid states by suitable scaling. All thin cylinders undergo second-order transitions at sufficiently high fluxoid. The correction due to finite coherence length is of the order of the fourth power of the ratio of the cylinder wall thickness to the coherence length. Other thin doubly connected superconductors are described by the same functions applicable to circular cylinders by making the appropriate correspondence of parameters. The exact second-order critical field for a torus is calculated. Systems of two coaxial magnetically coupled loops are analyzed and the critical conditions for one loop are found to depend in a complicated way on the presence of the other. If a thin loop is closely coupled to a thick one, the behavior of the former is dominated by that of the latter. Second order phase transition criteria are obtained for systems of n coaxial loops of equal radius. A comparison is made of the results obtained in this thesis with those appearing previously in the literature. (Diss. Abstr. Int., B)

32288 EFFECT OF NEUTRON IRRADIATION ON SOME TYPE-II SUPERCONDUCTORS. Sugisaki, Toshihiko; Okada, Touichi; Suita, Tokuo (Osaka Univ.). Technol. Rep. Osaka Univ.; 21: 385-97(Oct 1971).

The effects of neutron irradiation on the critical density, J_c, of Nb–50% Ti and Nb–25% Zr were studied. The J_c of as-drawn Nb–50% Ti wire was about doubled by irradiation total doses of 3.5×10^{16} fast neutrons/cm^2; the lattice defects introduced were found to pin the motion of quantized flux lines. The J_c of as-drawn Nb–25% Zr wire was decreased by neutron irradiation; this may correspond to a physical overlapping of the defects. (auth

32289 HOLLOW CURRENT-CARRYING SUPERCONDUCTING CYLINDER. Samuelsen, M. R. (Technical Univ., Lyngby, Denmark). Phys. Status Solidi (b); 50: No. 2, K131-3(1 Apr 1972).

A phenomenological description of the resistance of a current-carrying superconducting cylinder developed previously is extended to the hollow superconducting cylinder. (M.H.R.)

32290 THEORY OF NUCLEUS FORMATION IN PHASE TRANSITIONS IN MAGNETIC FIELDS. Privorotskii, I. A. (Inst. of Theoretical Physics, Moscow). $_{15}$JETP Lett. (USSR) (Engl. Transl.); 14: No. 12, 429-31(20 Dec 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 11, 613-16(5 Dec 1971).

Phase transitions are considered in superconductors and in diamagnetic metals (under conditions of the de Haas–van Alphen effect). It is assumed here that the dimensions of the nucleus are large compared with the thickness of the boundary between the normal and superconducting phases, which is valid in the case of weak metastability. (M.H.R.)

Equipment and Devices

Refer also to abstracts 31650, 31651, and 31657.

32291 SUPERCONDUCTORS FOR POWER TRANSMISSION. Snowden, Donald P. Sci. Amer.; 226: No. 4, 84-91(Apr 1972).

The rising demand for electricity conflicts with opposition to overhead transmission lines. The feasibility and economics of underground lines refrigerated to be superconducting are discussed as a solution. (M.H.R.)

32292 1/H DRIVE FOR USE WITH SUPERCONDUCTING SOLENOIDS. Everett, P. M. (Louisiana State Univ., Baton Rouge). Rev. Sci. Instrum.; 43: No. 5, 753-5(May 1972).

A circuit is presented that can be used with nearly all superconducting solenoid magnet systems to sweep the magnetic field such that equal intervals in the inverse of the field are progressed in each instant of time. The circuit produces a programming voltage that controls the total power supply current. The ideal situation of the resistanceless solenoid shunted by the virtually inductanceless persistent mode switch causes the programming voltage to assume a particularly simple form. (auth)

PHYSICS (NUCLEAR)

32293 (JAERI-M-4572) REQUESTS FOR NUCLEAR DATA MEASUREMENTS IN JAPAN, 1971. **Igarashi, Siniti** (Japan Atomic Energy Research Inst., Tokyo). Sep 1971. 13p. (In Japanese). NTIS (U. S. Sales Only).

In the list are presented the requests for nuclear data measurements in Japan to help advance the peaceful uses of atomic energy, for the fiscal year 1971. It is published also as part of the cooperation with EANDC and CCDN. (auth)

32294 (N-72-12685) NUCLEAR STRUCTURE INVESTIGATIONS WITH AN FN TANDEM ACCELERATOR. Progress Report, March 1, 1970–February 28, 1971. **Hanna, Stanley S.; Meyerhof, Walter E.** (Stanford Univ., Calif. Dept. of Physics). 15 Sep 1971. 187p. NTIS.

An active research program on the Tandem Van de Graaff accelerator is described. Low mass nuclei were studied by a variety of reactions and new levels were found whose properties could be compared with nuclear model calculations. Studies of the giant resonance continued and it was shown that the isospin splitting of the resonance probably also exists in lighter nuclei. The gamma and particle decays of several high-isospin states in the lighter nuclei were investigated. Analog states in several nuclei with A approximately 90 were located using elastic and inelastic scattering cross sections. A theory was developed which reproduces consistently the shapes of the cross sections, including the location of resonances. Gamma and particle emission in several heavy ion reactions was studied. (auth) (STAR)

Neutron Interactions with Matter

Refer also to abstracts 31640, 32343, 32606, 32717, and 32718.

32295 (AD-734203) NUMERICAL AND EXPERIMENTAL STUDIES OF SPECTRAL UNFOLDING. VOLUME I. Final Report. **Kendrick, Hugh; Harris, Lawrence Jr.** (Gulf Radiation Technology, San Diego, Calif.). 27 May 1971. Contract DASA01-70-C-0017. 189p. (GULF-RT-10486(Vol.1); DASA-2720-1). NTIS.

An experimental test of unfolding codes has been developed. This test consisted of measuring a neutron response matrix, and then a neutron spectrum by two different methods simultaneously, time-of-flight (TOF) and pulse-height unfolding, using the same detector. The structure in the spectra was varied by using different filters in the incident beam from the Linac pulsed source. Three filters and two different size NE-213 detectors (2-inch and 5-inch cylindrical) were used to obtain data to test two unfolding codes, FERDOR and the MAZE 1 code which was developed as part of this program. The agreement between the appropriately smoothed TOF spectra and the FERDOR unfolded spectra was generally very good. (auth) (NTIS)

32296 (AD-734204) NUMERICAL AND EXPERIMENTAL STUDIES OF SPECTRAL UNFOLDING. VOLUME II. Final Report. **Sperling, S. Martin; Kendrick, Hugh** (Gulf Radiation Technology, San Diego, Calif.). 27 May 1971. Contract DASA01-70-C-0017. 99p. (GULF-RT-10486(Vol.2); DASA-2720-2). NTIS.

A basic theory of unfolding has been implemented in a new unfolding code, MAZE 1. The two principles which underlie the theory are that a function W of the spectrum can be found such that the unfolded spectrum corresponds to the point that minimizes W and the smoothing strength varies dynamically to the largest value that still allows the folded spectrum to be consistent with the data. Multinomial statistics and the fact that the spectrum and the data are random variables were used in formulating the minimum principle. The W function which was developed includes a part corresponding to the maximum likelihood function and a smoothing part especially designed to be invisible to Gaussian peaks. A unique error estimation technique adapted to the nonquadratic form of W was developed. (auth) (NTIS)

32297 (CEA-R-4273) PULSED NEUTRON SOURCE USING A LASER BEAM. **Rabeau, Maxime** (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Jan 1972. 93p. (In French). Dep. NTIS (U. S. Sales Only).

The large number of ions produced when a Q-switched laser beam is focussed onto a target was used as the ion source of a pulsed neutron generator. Puffs of 10^7 neutrons in 400 nsec were obtained by irradiating a deuterium based cathode with the deuterons extracted from a deuterium-based T_i target. The experimental apparatus, the principles underlying the operation of the source, the diagnostic methods, and a simple mathematical model which gives a correct account of the experimental results are described. (auth)

32298 EXISTENCE, UNIQUENESS, AND STABILITY OF SOLUTIONS TO CHANDRASEKAR'S INTEGRODIFFERENTIAL EQUATION FOR X AND Y FUNCTIONS. **Nelson, William** (Purdue Univ., Lafayette, Ind.). J. Math. Anal. Appl.; 37: No. 3, 580-606 (Mar 1972).

A generalization of the initial value integrodifferential equations of Chandrasekar for X and Y functions is investigated. The generalization includes the equations of numerical interest in which integrals are replaced by a Gaussian quadrature. Local existence and uniqueness is proven for a broad class of initial conditions. Questions of global existence, solution boundedness and Liapunov stability are resolved for general positive initial conditions. Solutions corresponding to the "nonconservative case" in radiative transfer problems are shown to be stable; those corresponding to the "conservative case" are shown to be unstable. (auth)

32299 EXPERIMENTAL AND THEORETICAL ANALYSIS OF FAST NEUTRON SPECTRA. **van Dam, Hugo.** Delft, Netherlands; Technische Hogeschool (1971). 114p.

Thesis.

A theoretical and experimental analysis of fast neutron spectra, with emphasis on resonance scattering effects and the influence of anisotropic scattering on the space-energy distribution, is presented. The neutron transport equation is examined in detail. Group cross section evaluation is discussed and some examples given. Results of calculations and measurements for a fast neutron spectrum assembly are discussed. (J.W.R.)

32300 ROTATIONAL CORRELATION FUNCTION OF SPHERICAL ROTORS AND NEUTRON SCATTERING. **Hama, Juichiro; Nakamura, Tuto** (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 6, 1666-89(Dec 1971).

The rotational correlation function for non-interacting spherical molecules is treated exactly in an analytical form. The result is then applied to the inelastic scattering of neutrons by gas of spherical molecules. The intermediate scattering function for hydrogenic molecules is studied on the basis of its integral representation with a known transcendental function. It is shown that the above function is, in the limiting case of short time, identified with the basic equation in the effective mass theory of Sachs and Teller. The intensity to be attributed to the quasi-elastic peak is given also analytically. Both the quasi-classical approximation and the effective mass theory are examined in comparison of their results with the exact one for the inelastic neutron spectra for some scattering angles, with a specific reference to methane. (auth)

32301 COMMENTS ON THE EFFECT OF TRANSVERSE DIMENSIONS ON THE DIFFUSION LENGTH IN CRYSTALLINE MODERATORS. **Williams, M. M. R.** (Queen Mary Coll., London). Nucl. Sci. Eng.; 47: No. 4, 498-9(Apr 1972).

The criticism by Ahmed, Kothari, and Kumar (Nucl. Sci. Eng., 46: 203 (1971)) of Williams (Nucleonik, 11: 219 (1968)) concerning the behavior of the neutron diffusion length in systems with finite transverse dimensions is answered. It is shown that the assumption of space-energy separability was not made. (J.W.R.)

32302 SOLUTION TO THE MONOENERGETIC NEUTRON BOLTZMANN EQUATION FOR A FINITE PARALLELEPIPED. **Boffi, V. C.; Molinari, V. G.** (CNEN, Bologna). Transp. Theory Statist. Phys.; 1: No. 4, 313-28(1971).

A solution to the integro-differential Boltzmann equation, which governs the steady-state space-angle distribution of the flux of monoenergetic neutrons in a rectangular parallelepiped of an isotropically scattering material, is presented. Results for both the angular and the total fluxes are obtained by resorting to a three-dimensional Fourier transform technique. The non-singular linear integral equation for the transform of the total flux is studied by considering the integral transformation associated with its kernel. This transformation is recognized to be compact. In view of this compactness, the kernel of the given non-singular transform equation can then be approximated, as closely as desired, by a kernel of finite rank. The solution thus obtained is finally transformed back to yield the original total flux distribution, from which the angular flux distribution also follows. (auth)

32303 ORDER OF NEUTRON-SCATTERING METHOD IN PLANE GEOMETRY: ONE-VELOCITY PROBLEMS. **Papmehl,**

N.; Zech, Hans J. (Ruhr-Univ., Bochum, Ger.). Nucl. Sci. Eng.; 47: No. 4, 435-48(Apr 1972).

An explicit formulation of the one-velocity order of scattering method for neutrons is developed assuming plane geometry and anisotropic scattering. Calculations for the half-space albedo problem based on this method were performed for isotropic scattering and were checked against known results. Further numerical studies of reflection and transmission of slabs yield detailed information about the order of scattering needed for a desired accuracy and for given thickness and absorption of the slab. For slab thickness up to one mean-free-path eighth order of scattering is shown to yield deviations from exact values of <1%. (auth)

32304 EXPERIMENTAL AND ANALYTICAL STUDIES OF FAST NEUTRON TRANSPORT IN IRON. Malaviya, B. K.; Kaushal, N. N.; Becker, M.; (and others) (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Sci. Eng.; 47: No. 3, 329-48(Mar 1972).

As part of a comprehensive program devoted to the integral checks of differential microscopic cross-section data pertinent to the LMFBR program, the experimental and analytical investigations of fast neutron transport in bulk assemblies of iron are described. Time-of-flight measured fast-neutron angular flux spectra at different positions in a simple, clean, homogeneous assembly are analyzed using ENDF/B data as input, MC^2 code system, and S_N transport calculations. In addition, continuous slowing down theory has been developed to complement precise calculations by indicating direct relationships between cross-section uncertainties and spectra; this approach permits integrating other non-ENDF/B data in the analysis. The well-defined integral experiment permits clear-cut interpretation leading to definitive conclusions with respect to input data and also to checks of standard analytical codes. The Karlsruhe (KEDAK) data set and the ENDF/B-I and ENDF/B-II files for iron have been assessed. On the basis of cross-section uncertainties in iron and of their influence on spectra, it is possible to recommend not only preferred data, but also a redirection in emphasis in differential measurements and evaluation. For fast reactor applications, ENDF/B-I set is preferable, subject to certain limitations. (auth)

32305 COMPILATION AND DISTRIBUTION OF NEUTRONIC DATA. Liskien, H. (Neutron Data Compilation Centre, Saclay, France). pp 275-80 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

Interest in neutronic data has led to specialized information systems. By taking an experiment in nuclear chemistry as an example, it is shown how such an experiment is stimulated and promoted by compiling and publishing "Requests for Neutron Data Measurements (RENDA)". After completion of the experiment, entries for the "Computer Index for Neutron Data (CINDA)" will be prepared, while numerical results will be exchanged among four co-operating neutron data centres (EXFOR). These four corresponding libraries of experimental data form the basic source for evaluators who update national libraries containing evaluated neutron data, the quality of which can be checked indirectly by integral measurements. (5 references) (auth)

32306 NEUTRON DIFFUSION IN A MEDIUM CONTAINING CHANNELS. Laletin, N. I. At. Energ. (USSR); 32: No. 4, 328-30(Apr 1972). (In Russian).

A theoretical treatment is given for the coefficient of diffusion cooling during anisotropic diffusion and for the damping of neutron momenta in an assembly with one central channel. (K.S.W.)

32307 ORDERS-OF-SCATTERING METHOD FOR FAST-NEUTRON TRANSPORT. Thiesing, James William Jr. Manhattan, Kan.; Kansas State Univ. (1971). 158p. University Microfilms Order No. 72-9773.

Thesis.

The orders-of-scattering technique for fast-neutron transport is developed and discussed in detail and the applicability of the technique to penetration and reflection problems is illustrated. Angular and energy dependent orders-of-scattering calculations, in which the contributions to the flux from once-scattered, twice-scattered, etc., neutrons are calculated separately, were performed for the reflection and penetration of a pencil beam of polyenergetic fast neutron through slabs of steel and water. In the calculations, the DLC-2 grouped cross section set, which contains 27 energy groups spanning the range 1 to 14 MeV, was used to provide total cross sections and angular dependent scattering cross sections. Single- and double-scattering calculations were carried out for the case of a pencil beam incident at an arbitrary angle on an infinite slab with a detector located at a given point relative to the slab orientation. Experiments were performed for the case of collimated reactor neutrons incident on 4.62 cm, 9.99 cm, and 15.24 cm thick steel slabs and 10.16 cm and 20.32 cm thick water slabs. The KSU NE-213 fast-neutron spectrometer system was utilized in the experimental measurements. These experiments approximated closely the configurations used in the orders-of-scattering calculations and were used to test the application of this technique in fast-neutron transport. The orders-of-scattering calculations for the reflection problems showed good agreement with the experimental results in both energy spectrum and absolute magnitude for reflection from relatively thick slabs. Agreement was also good for penetration through slabs of moderate thickness. Energy spectrum plots of the experimental results and the corresponding orders-of-scattering calculations are included for nine different slab-detector orientations for steel and for six orientations for water. The computer codes, SINGDET and DOUBDET, used to carry out the single- and double-scattering calculations are included along with a detailed discussion of the computational procedures employed. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, A ≤ 5

Refer also to abstract 32318.

32308 (LBL-705) DOUBLE CHARGE EXCHANGE ON ^{4}He AND ^{3}He LEADING TO MULTI-NEUTRON FINAL STATES. Perez-Mendez, V.; Sperinde, J. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jan 1972. Contract W-7405-eng-48. 16p. (CONF-710948-1). Dep. NTIS.

From International seminar on pion-nucleus interactions; Strasbourg, France (Sep 1971).

Evidence for a low energy resonant behavior in the $T = 3/2$ three-neutron system is presented. (auth)

32309 NUCLEON-NUCLEON SCATTERING PARAMETERS FROM THREE-PARTICLE FINAL STATE REACTIONS. van Oers, W. T. H. (Univ. of Manitoba, Winnipeg). Particles Nucl.; 2: No. 4, 207-57(Oct 1971).

Precise data on the $^1S_0$ nucleon-nucleon scattering parameters are a prerequisite for a determination of the extent to which charge independence and charge symmetry of nuclear forces hold. Since colliding neutron beam experiments have not been performed to date, neutron-neutron final-state interactions in many-particle reactions have been the only source of information for the neutron-neutron scattering parameters. The third particle, or more precisely the nature of its interaction with the nucleons, determines primarily the distortions of the final-state interaction of interest. In general, the criteria for the application of the Watson-Migdal theory in the analysis of final-state interactions are only met approximately. The spectra exhibiting a nucleon-nucleon final-state interaction in a three-particle reaction also have been analyzed using less stringent criteria, i.e., by using a modified Born approximation and, for the two-nucleon interaction, a general spin-dependent central potential. The results obtained by various authors with this type of approach are encouraging. Attempts have been made to extract the neutron-neutron scattering parameters by applying a comparison procedure using the Watson-Migdal theory or a modified Born approximation. The results from these analyses are in many instances far from satisfactory. The most reliable experimental value for the neutron-neutron scattering length is at present still based upon the $D(\pi^-,\gamma)2n$ reaction. (auth)

32310 ABSORPTION OF PIONS BY THREE-BODY NUCLEI IN THE (3,3) RESONANCE REGION. Lazard, C.; Maric, Z. (Institut de Physique Nucleaire, Orsay, France). Nuovo Cim.; 8A: No. 4, 689-702(21 Apr 1972).

The effect of the diffractional minimum, seen in electron scattering on three-body nuclei, is studied in the pion absorption reaction with the subsequent emission of two energetic nucleons. The calculation is performed in the energy region of the first pion-nucleon resonance. The effect of pion rescattering is taken into account. It is shown that the completely symmetric S-component of the ground-state wave function for ^{3}H and ^{3}He nuclei with and without the core part causes the different behavior of the differential cross section and therefore additional information on the diffractional minimum can be gained. A specific and experimentally easily realizable kinematics is suggested. (auth)

32311 PION PRODUCTION IN THE REACTIONS $d(p,\pi^+)t$, $^3He(p,\pi^+)^4He$, AND $^4He(p,\pi^+)^5He$. Gabathuler, K. (Lab. for

High-Energy Physics, Zurich); Rohlin, J.; Domingo, J. J.; (and others). Nucl. Phys.; B40: 32-8(1972).

Differential ground-state capture cross sections were measured at 0° and $T_p = 600$ MeV for the reactions $d(p,\pi^+)t$, $^3He(p,\pi^+)$ ^4He and $^4He(p,\pi^+)^5He$. The cross sections are found to be large, of the order of 10 μb/sr in c.m.s. in fair agreement with recent predictions. (auth)

32312 EXPERIMENTAL INVESTIGATION OF THE REACTION A(N,Z) $(\pi^+,2p)$ B(N-2,Z-1) ON NUCLEI ^2H, ^6Li, ^7Li, ^{12}C AND ^{16}O AT $T_\pi = 70$ MeV. Swannack, Clarke Elliott. Pittsburgh; Carnegie-Mellon Univ. (1972). 264p. University Microfilms Order No. 72-12, 706.

Thesis.

The reaction A(N,Z) $(\pi^+,2p)$ B(N-2,Z-1) was investigated for target nuclei deuterium, ^6Li, ^7Li, ^{12}C, and ^{16}O. The pion laboratory energy was 70 MeV, and its momentum was analyzed with a spark chamber magnetic spectrometer beam line. The pion trajectory and the final state proton trajectories were measured with digitized, magnetic core spark chambers coupled on-line to a PDP-7 computer. The proton energies were measured with two digitized range chambers of 32 gaps each with adjustable absorption settings. The proton energies were measured between about 50 to 150 MeV, and the center-of-mass production angles were measured from 45° to 135°. The absorption reaction $\pi^+ + d \rightarrow p + p$ provided the energy calibration of the range chambers and was derived from data produced from a 0.25 inch D_2O target. For the 3 MeV/gap range chamber setting data reported in this thesis, the missing mass peak resolution had a standard deviation of 3.2 MeV/c^2. The $\pi^+ + d \rightarrow p + p$ differential cross-section was best fit to $d\sigma/d\Omega = 0.2473\ (\pm .0073) + 0.9742\ (\pm .0615) \cos^2\theta$ mb/sr, and $\sigma = 7.19\ (\pm .26)$ mb. These values were in agreement with existing data. The reaction ^6Li $(\pi^+,2p)^4He$ leading to the ground state of ^4He was investigated in detail using 2.0 cm. ^6Li and 0.1 in ^6Li targets. The recoil momentum spectrum was fit well to a Hulthen wave function. The production angle differential cross-section had an excellent fit to the values $d\sigma/d\Omega = 0.2348\ (\pm .0061) + 1.061\ (\pm .0369) \cos^2\theta$ mb/sr, and $\sigma = 7.394\ (\pm .158)$ mb which were virtually identical to real $\pi d \rightarrow 2p$ values. By taking the α core shielding effect into account by a classical geometric calculation, the total cross-section for the peripheral absorption process was found to be 11.72 (±1.0) mb, implying the coupling of $^6Li \rightarrow \alpha + d = 1.63$ (±.2). The excited level of ^4He exhibited fine structure between 20 and 35 MeV/c^2. The recoil momentum distribution peaked near 140 MeV/c. The differential cross-section followed the same shape as real $\pi d \rightarrow 2p$, but was of much larger total cross-section. Pion absorption data from 0.25 inch ^7Li target exhibited fine structure within broad peaks of the ^5He missing mass spectrum. The recoil momentum cross-section exhibited a double peak structure for events near 0 MeV/c^2 missing mass, and the production angle differential cross-section was completely dissimilar to πd absorption. The missing mass spectrum for ^{10}B from π^+ absorption on ^{12}C exhibited a broad peak of 10 MeV/c^2 width centered at 2 MeV/c^2 excitation. The ground state contribution was noticeably suppressed. The recoil momentum spectrum for events within this mass range peaked beyond the defined measurement limits, and was otherwise featureless. The production angle differential cross-section was much flatter than real πd absorption. The ^{16}O reaction leading to ^{14}N was characterized by a near absence of events leading to the ^{14}N ground state, a composite peak centered at 5 MeV/c^2 excitation, and a narrow peak between 10 and 12 MeV/c^2 of small amplitude. Within the 5 MeV/c^2 level the recoil momentum exhibited a double component structure. The differential cross-section for these events was significantly flatter than real $\pi d \rightarrow 2p$. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 32312 and 32450.

32313 (FRNC-TH-151) ELASTIC SCATTERING OF PROTONS (3 TO 3.6 MeV) BY ^{14}N AND THE DETERMINATION OF THE SPIN AND PARITY OF EXCITED ^{15}O LEVELS. Diallo, Oumar (Lyon Univ. (France)). 1971. 86p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The excited levels of ^{15}O were studied from data on the elastic scattering of protons by the ^{14}N nucleus in 3 to 3.6 MeV energy range. The compound nucleus model based on the R matrix was used to study the theoretical aspects of the problem. The spin and parity of the 10.5, 10.47 and 10.29 MeV excited levels were determined by analyzing the anomalies observed in the excitation curves at 3209, 3215, 3410 and 3440 keV. (France)

32314 (KFK-1510) FIRST 4^+ STATE OF ^{12}C AND A LEVEL AT 15.6 MeV. Fawzi, M. A.; Haase, E. L.; Saylor, D. P.; Hagelberg, R. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Dec 1971. 11p. Dep. NTIS (U. S. Sales Only).

Measurements of the $^{14}N(d,\alpha'\alpha)$ and of the $^{12}C(\alpha,\alpha')$ reactions confirm a broad level in ^{12}C at 15.6 MeV. Analysis of α-particle inelastic angular distributions indicates that this level is the 4^+ member of the ground-state rotational band. Reconsideration of earlier experiments shows them to be consistent with a 3^- assignment for the level at 14.08 MeV previously thought to have 4^+. (auth)

32315 (LYCEN-7177) INVESTIGATIONS, USING THE NILSSON MODEL, OF THE ELECTROMAGNETIC ENERGY LEVELS AND TRANSITIONS INVOLVING NUCLEI WITH N, OR Z = 11 OR 13. Desgrolard, Pierre (Lyon Univ. (France). Institut de Physique Nucleaire). Nov 1971. 96p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The spectroscopic and electromagnetic properties of the first excited levels of ^{21}Ne, ^{21}Na, ^{19}O, and ^{23}Ne were investigated. The nuclear model used is based on the Bohr–Mottelson unified model. The nucleus is considered as a rotating deformed but rigid core, the single outer nucleon moving inside the rotating potential created by the core. Configurations corresponding to different cores are separately calculated, taking into account the negative parity states (the nucleon states obeying the Pauli principle). The wave function formalism is established and the electromagnetic transition rates and static moments are derived. Lifetimes and branching and mixing ratios are also given for the various levels. Results obtained with ^{21}Ne, ^{21}Na, ^{19}O and ^{23}Ne are compared with those relating to adjacent nuclei with Z or N = 11 (^{23}Na, ^{23}Mg) or Z or N = 13 (^{25}Mg, ^{25}Al, ^{27}Si, and ^{27}Al). (France)

32316 (ORNL-4780) NEUTRON ELASTIC- AND INELASTIC-SCATTERING CROSS SECTIONS FOR OXYGEN IN THE ENERGY RANGE 4.34 TO 8.56 MeV. Kinney, W. E.; Perey, F. G. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 36p. Dep. NTIS.

Numerical values for neutron elastic- and inelastic-scattering cross sections for oxygen from 4.34 to 8.56 MeV are given. The data are in generally good agreement with the results of others and are well described by ENDF/B evaluations. (auth)

32317 (ORO-4317-1) OPTICAL MODEL CALCULATIONS WITH A REALISTIC NUCLEON–NUCLEON INTERACTION. I: THEORY. Technical Report No. 72-069. Lerner, Gerald M.; Redish, Edward F. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Feb 1972. 60p. Dep. NTIS.

The real parts of the optical potentials for the elastic scattering of 65-MeV protons by ^{16}O, ^{17}O, and ^{18}O are calculated in an impulse approximation. The prescription used is derived from three-body theory by considering the system as consisting of the incident nucleon, an active bound nucleon, and an inert core. The effective interaction resulting is a fully off-shell T matrix and is both nonlocal and energy dependent. Reid's soft core potential is used to generate the requisite T matrices. Antisymmetry between the incident and active nucleon is included, and all relative two-nucleon partial waves with $l \leq 3$ are retained. The optical potential is constructed by assuming a pure shell-model target and summing the state of the active nucleon through the single-particle states. The resulting nonlocality is investigated explicitly and is found to be negligible. A coordinate space potential is constructed. When compared to the real parts of phenomenologically generated optical potentials, these potentials are found to be similar in the surface ($r \sim 2.5$ fm) but deeper in the interior. When the parameter-free real well is combined with phenomenological imaginary and spin–orbit wells, high-quality fits to the experimental data are obtained, comparable to those obtained when all three wells are chosen phenomenologically. Off-energy shell effects and the energy dependence are investigated. (11 figures, 5 tables) (auth)

32318 USE OF THEORETICAL POTENTIAL FOR THE SCATTERING PROBLEM OF TWO ALPHA PARTICLES. Pipiraite, P. P. (Shaulyai Pedagogical Inst., USSR). Liet. Fiz. Rinkinys; 11: No. 2, 223-7(1971). (In Russian).

An α interaction potential found previously is used for calculations of the binding energy of nucleus ^8Be, of the scattering differential cross section in the first Born approximation, and of S-phase shifts at energy range 3–10 MeV. (auth)

32319 NUCLEAR-COULOMB INTERFERENCE IN π^+–^{12}C SCATTERING. Scott, M. L. (Rice Univ., Houston, Tex.); Mutchler, G. S.; Fletcher, C. R.; (and others). Phys. Rev. Lett.; 28: No. 18, 1209-11(1 May 1972).

The small-angle scattering of π^+ from ^{12}C was measured at 115, 167, and 242 MeV. The measurements covered the Coulomb-nuclear interference region from 3 to 10°. The real part of the forward nuclear amplitude was extracted from the data. (auth)

32320 STUDY OF THE ^{11}B(^{3}He,p)^{13}C REACTION. Wu, Ruey Ren Athens, Ga.; Univ. of Georgia (1971). 98p. University Microfilms Order No. 72-2561.

Thesis.

A charged-particle identification system including E and ΔE solid state detectors has been used to investigate the ^{11}B(^{3}He,p) ^{13}C reaction at incident ^{3}He energies of 4, 6, 8, 10, and 12 MeV. With this system overall proton resolutions of 50 keV have been obtained. Angular distributions for ten proton groups corresponding to states in ^{13}C have been measured. These states are p_0 (ground state), p_1 (3.09), p_2 (3.68), p_3 (3.85), p_6 (6.87), p_7 (7.50), p_8 (7.55), p_9 (7.68), p_{12} (9.51), and p_{13} (9.90). The angular distributions have been fitted with DWBA analysis using zero-range approximation. No radial cutoffs were used. In general the data are reasonably well fitted at incident energies of 10 and 12 MeV. (Diss. Abstr. Int., B)

32321 CALCULATIONS ON (γ,p) AND (γ,n) REACTIONS AT PHOTON ENERGIES BETWEEN 40 AND 100 MeV. Fink, M.; Hebach, H.; Kuemmel, H. (Ruhr-Univ., Bochum, Ger.). Nucl. Phys.; A186: No. 2, 353-64(1972).

Shell-model calculations with and without short-range correlations have been carried out for the reactions (γ, p) and (γ, n) in the energy region from 40 to 100 MeV. The cross sections for the ^{16}O(γ, p)^{15}N process have been investigated in the single-particle model. The results strongly depend on the initial state wave functions especially at high energies. There are large effects on the cross sections if orthogonality between bound and continuum states is violated. For the reaction ^{16}O(γ, n)^{15}O it is shown that short-range correlations in the ground state of ^{16}O do not contribute appreciably to the cross sections, at least up to a photon energy of 100 MeV. (auth)

32322 LOW-ENERGY PHOTODISINTEGRATION OF ^{6}Li. Ghovaniou, Ali Hadji. Washington, D. C.; George Washington Univ. (1971). 103p. University Microfilms Order No. 72-8999.

Thesis.

The cross section for the photodisintegration $\gamma + {}^6\mathrm{Li} \rightarrow \alpha + n + p$ has been calculated for photon energies from threshold ($E\gamma = 3.7$ MeV) up to $E\gamma = 25$ MeV utilizing dispersion theory methods. In this energy region the dominant contribution to the transition amplitude results from three diagrams characterized respectively by the virtual breakups $^6\mathrm{Li} \rightarrow \alpha + d$, $^6\mathrm{Li} \rightarrow {}^5\mathrm{He}_{g.s} + p$ and $\alpha - n$ rescattering correction to the first. In the calculation, the coupling constant for the $^6\mathrm{Li} \rightarrow \alpha + d$ vertex is taken from an analysis of $\alpha - {}^6$Li elastic scattering differential cross section. The $^6\mathrm{Li} \rightarrow {}^5\mathrm{He} + p$ coupling constant is determined from an analysis of the deuteron energy distribution in the reaction $n + {}^6\mathrm{Li} \rightarrow n + \alpha + d$. The predicted cross section accounts for practically all of the measured $\sigma(\gamma,n)$ in the low energy region. The calculated cross section integrated up to the ^{3}H + ^{3}He threshold is 11.7 MeV mb while experimentally it is found to be 12.4 to 13.5 MeV mb. The rms charge radius, calculated from the diagrams described above, is 2.45 F, in good agreement with the experimental value of 2.50 F. (Diss. Abstr. Int., B)

32323 PRODUCTION OF THREE ^{4}He NUCLEI BY THE DIRECT INTERACTION OF ^{6}Li WITH ^{6}Li AT BOMBARDING ENERGIES OF 2.0, 6.0, AND 13.0 MeV. Gadeken, Larry Lee. Iowa City, Iowa; Univ. of Iowa (1971). 88p. University Microfilms Order No. 72-8245.

Thesis.

A study was made of the production of three ^{4}He nuclei by a direct process, rather than via an intermediate stage, for the ^{6}Li + ^{6}Li reaction at bombarding energies of 2.0, 6.0, and 13.0 MeV. The experimental energy spectra were fitted by using a simple model which assumed an α + d cluster structure for the ^{6}Li nuclei and an interaction potential acting only between the deuterons. (Diss. Abstr. Int., B)

32324 ^{13}C(^{3}He,n)^{15}O REACTION AT 6.0-MeV BOMBARDING ENERGY BY NEUTRON TIME-OF-FLIGHT. Hinderliter, Hilton Fay. University Park, Pa.; Pennsylvania State Univ. (1971). 123p. University Microfilms Order No. 72-9476.

Thesis.

Principal proton configurations and spectroscopic factors for ^{15}O levels have been found from a DWBA analysis of the differential cross sections recorded for the ^{13}C(^{3}He,n)^{15}O reaction at 6.0-MeV bombarding energy. The carbon targets were enriched to 54% ^{13}C, and the neutrons were observed with a time-of-flight system of 3.18 m flight path. The results for positive-parity levels agree well with those configurations previously determined by others. Since such an analysis cannot yield the detailed mixtures in the ^{15}O wave-functions, only pure configurations have been considered, even though it has been found that small mixtures in the wavefunctions can change the results significantly. Not only are shell-model admixtures likely to complicate the picture, but also there may be an appreciable content of core polarization admixtures involved. Thus, the results presented here are preliminary—being based upon several unrealistic assumptions (with regard to optical model parameters and purity of wavefunctions) necessary for carrying out the calculations. Even so, the principal configurations found from this simplified analysis agree remarkably well with results reported elsewhere, and thus confirm these descriptions of the ^{15}O levels in question. (Diss. Abstr. Int., B)

32325 STUDY OF DWBA THROUGH PROTON PICKUP FROM ^{6}Li. Hertzog, Russel Cleveland Jr. Providence; Brown Univ. (1971). 82p. University Microfilms Order No. 72-8123.

Thesis.

The ^{6}Li(n,d)^{5}He ground state angular distribution provides a favorable situation for studying the well known failure of conventional distorted-wave Born approximation analysis. The ground state angular distribution has not been fitted and there is disagreement among the reported distributions. In this experiment a counter telescope with good geometry was used to examine the ^{6}Li(n,d)^{5}He ground state angular distribution with high precision. The telescope consists of two continuous flow Ar–CO_2 gas proportional counters in tandem with a CsI(Tl) scintillation counter. The pulses from each detector preamplifier are fed into a particle discrimination system. Besides providing the necessary coincidence conditions, the particle discrimination system electronically simulates the polynomial analog of the Bethe–Bloch formula providing particle identification signals which are used to route the energy spectra for each kind of particle into a different portion of a multichannel analyzer memory. A thick target of $^6Li_2CO_3$ was fabricated to offset the low counting rates intrinsic to the good geometrical configuration necessary for angular resolution. Results obtained consist of the experimental angular distribution, an improvement upon previous determinations, and extended DWBA analysis assessing the value of finite range, non-local interactions in improving the fit to the data. (Diss. Abstr. Int., B)

32326 STUDY OF GAMMA RAYS EMITTED FOLLOWING 250 MeV NEGATIVE PION SCATTERING ON ^{16}O. Lieb, Barnard Joseph Jr. Williamsburg, Va.; Coll. of William and Mary (1971). 126p. University Microfilms Order No. 72-9567.

Thesis.

The spectrum of gamma rays emitted following 250 MeV negative pion scattering on ^{16}O has been studied using a Ge(Li) detector. The gamma rays were detected in coincidence with an incident pion signature in three scintillation counters. Cross sections were measured for pion interactions resulting in excited states of ^{16}O, ^{16}N, ^{15}O, ^{15}N, ^{14}N, ^{14}C, ^{13}C, and ^{12}C. The cross section for pion induced neutron knockout leading to the first $3/2^-$ state of ^{15}O is 15.6 ± 3.8 mb. This can be compared to a recent cross section measurement for the same reaction at 180 MeV for all bound states of ^{15}O which is 42 mb. The ratio of the cross section for the ^{15}O $3/2^-$ state to that of its mirror state in ^{15}N is 1.7 ± .4 compared to the quasi-free prediction of 3. The relative cross sections for reactions leading to excited states of ^{15}N and ^{15}O are compatible with a quasi-free interpretation but the excitation of the $5/2^+$ levels relative to the $3/2^-$ levels is a factor of ~3 greater than expected. Comparison with the decay schemes of the giant dipole states indicates that significant excitation of these states would result in greater relative excitation of the $5/2^+$ levels and would help to explain the observed neutron to proton knockout ratio. Cross sections for two nucleon knockout resulting in excited states of ^{14}N are found to be comparable to those for single nucleon knockout. The ratio of the first O^+ (T = 1) excited state to that of the 1^+ (T = 0) state at 3.945 MeV is .39 ± .22 which can be understood in terms of a pion-nucleon pair interaction with the isospins coupled to T = 1. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, $20 \leq A \leq 38$

Refer also to abstracts 31063, 32035, 32315, 32373, 32388, 32415, and 32461.

32327 (JINR–E7-6303) MASS MEASUREMENTS OF ^{21}O AND ^{22}O. Artukh, A. G.; Gridnev, G. F.; Mikheev, V. L.; Volkov, V. V.; Wilczynski, J. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 14p. Dep. NTIS (U. S. Sales Only).

The ground state masses of ^{21}O and ^{22}O were determined from the Q-value measurements of the $^{232}Th(^{22}Ne,^{21}O_{g.s.})^{233}U_{g.s.}$ and $^{232}Th(^{22}Ne,^{22}O_{g.s.})^{232}U_{g.s.}$ reactions. The M–A values for ^{21}O and ^{22}O were found to be 9.3 MeV and 11.5 MeV, respectively. The detection method combining a magnetic analysis and a $\Delta E-E$-technique is used. (auth)

32328 (LA–4892) ANALYZING POWER IN $Si(\vec{p},p)$ BELOW 15 MeV. Hardekopf, R. A.; Armstrong, D. D.; Keaton, P. W. Jr. (Los Alamos Scientific Lab., N. Mex.). Mar 1972. Contract W-7405-eng-36. 6p. Dep. NTIS.

Analysing powers, A_y, were measured for protons elastically scattered from a natural silicon target in the energy range 5 to 15 MeV. Angular distributions of A_y were obtained at 5.16, 7.50, and 12.50 MeV using a thin (~0.25 mg/cm^2) target. Excitation functions of A_y were measured with a 6 mg/cm^2 target at several angles. The results indicate that silicon has only limited usefulness as a polarimeter for protons in the energy range of 5 to 15 MeV. (auth)

32329 (LBL–24) NUCLEAR EXCITATION OF Al, Si, Ca, AND Co PRODUCED BY μ^- CAPTURE. Temple, L. E.; Kaplan, S. N.; Pyle, R. V.; Valby, G. F. (California Univ., Berkeley. Lawrence Berkeley Lab.). Dec 1971. Contract W-7405-eng-48. 29p. (CONF-710933–4). Dep. NTIS.

From Muon physics conference; Fort Collins, Colo. (6 Sep 1971).

De-excitation gamma rays from residual nuclei following μ^- capture in natural Al, Si, Ca, and Co targets were observed. The results are consistent with neutron emission data and previously reported gamma transition measurements. The identified gamma transitions account for 81, 42, 42, and 71% of the nuclear muon captures respectively in Al, Si, Ca, and Co. Charged-particle emission is observed 14% of the time in Ca, 10% of the time in Si, and not at all in Al and Co. Levels corresponding to an excitation energy of 27 MeV above the ground state in ^{59}Co and more than 20 MeV above the ground state in the other targets were observed. Levels populated in the $^{40}Ca(\mu^-,\nu n)^{39}K$ reaction correlate closely with those observed in the $^{40}Ca(\gamma,p\gamma')^{39}K$ photoexcitation reaction. Comparison of the Si target results with the photoexcitation and electro-excitation reactions on ^{28}Si suggest the presence of a giant magnetic resonance in muon capture. (auth)

32330 (LUNP–7107) ON THE DECAY OF BOUND ISOBARIC ANALOGUE LEVELS IN ^{28}Si. Nilsson, L. (Tandem Accelerator Lab., Uppsala (Sweden)); Lyttkens, J.; Nilsson, A.; Bergqvist, I. (Lund Univ. (Sweden). Dept. of Physics). May 1971. 18p. Dep. NTIS (U. S. Sales Only).

The decay of bound isobaric analog levels in ^{28}Si was studied by the $^{27}Al(d,n\gamma)^{28}Si$ reaction. The isobaric analog levels are prominently populated by the (d,n) reaction. The deuteron energy was 4 MeV. The neutron energies were measured by time-of-flight techniques and a 25-cm^3 Ge(Li) detector was used to determine gamma-ray energies and intensities. The neutron detector was placed in the forward direction to emphasize the excitation of $l_p = 0$ levels in the residual nucleus. The coincidences between neutrons and gamma rays produced in the $(d,n\gamma)$ reaction were recorded in a two-parameter mode. The decay of levels at 9.316, 9.382 and 11.437 MeV is reported. (auth) (Sweden)

32331 (UJF–2772-F) MULTIPOLE MIXING RATIOS OF THE LOW-ENERGY TRANSITIONS IN ^{36}Cl NUCLEUS. Honzatko, J.; Kajfosz, J.; Kosina, Z. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1972. 16p. Dep. NTIS (U. S. Sales Only).

Linear polarization of the gamma rays following thermal neutron capture in ^{35}Cl has been measured with the aim to determine the spins of the low-lying excited states as well as the E2/M1 mixing ratios (δ_1 and δ_2) for the most intense transitions. The results are presented and discussed together with those obtained in different types of experiments described in literature. (auth)

32332 LOCATION OF THE SECOND $J^\pi = 0^+$, $T = 1$ STATE IN ^{26}Al. Noe, J. W.; Balamuth, D. P.; Betts, R. R.; Fortune, H. T.; Zurmuehle, R. W. (Univ. of Pennsylvania, Philadelphia). Nucl. Phys.; A186: No. 1, 15-27(1972).

Gamma-ray branching ratios have been measured for several states near $E_x = 3.7$ MeV in ^{26}Al with the $^{24}Mg(\tau,p\gamma)$, $^{25}Mg(\tau,d\gamma)$ and $^{27}Al(\tau,\alpha\gamma)$ reactions. Reaction particles were detected at 0° in coincidence with de-excitation γ-rays. Proton angular distributions were measured at $E_\tau = 11$ MeV for the $^{24}Mg(\tau,p)^{26}Al$ reaction to the 3.72 and 3.75 MeV levels. The results yield an assignment of $J^\pi = 1^+$, $T = 0$ for the 3.72 MeV state, in disagreement with a recent $J^\pi = 0^+$, $T = 1$ assignment, but in agreement with an earlier assignment of $J = 1$. The 3.75 MeV level is observed to be a close doublet. One member of this doublet is preferentially excited in the $^{25}Mg(\tau,d\gamma)$ and $^{27}Al(\tau,\alpha\gamma)$ reactions and is associated with a previous assignment of $J^\pi = 2^+$ or 3^+. The second member of the 3.75 MeV doublet is preferentially excited in the $^{24}Mg(\tau,p\gamma)$ reaction and is identified as the second 0^+, $T = 1$ state in ^{26}Al. Branching ratio results for the 3.68 MeV level establish that this level is also a close doublet. Results for the 3.59 MeV state are in agreement with previous work. (auth)

32333 BETA-NEUTRINO CORRELATIONS AND RECOIL NUCLEAR ALIGNMENT EFFECTS IN LIGHT DELAYED PARTICLE EMITTERS. Macfarlane, R. D.; Nickles, R. K.; Oakey, N. S. (Niels Bohr Inst., Copenhagen. Texas A and M Univ., College Station). pp 136–47 of Research Report No. 4/1970. Jyvaskyla, Finland; Jyvaskyla Univ. (1970). (CONF-700832–1).

From Nuclear structure symposium of the Thousand Lakes; Joutsa, Finland (2 Aug 1970).

An analysis of the Doppler-broadened line shapes of α-groups from the β-delayed α-decay of ^{20}Na has revealed a simple method of obtaining $\beta^+-\nu$ anisotropy coefficients which is applicable for all of the β-delayed particle emitters in the light elements. In addition, a new approach to studying the longitudinal polarization and nuclear alignment of the β-recoil has emerged from the same analysis. (auth) (Finland)

32334 MASS, DECAY PROPERTIES, AND LEVELS OF ^{36}K FROM THE $^{36}Ar(p,n)^{36}K$ and $^{36}Ar(^3He,t)^{36}K$ REACTIONS. Miller, Daniel William. Raleigh, N. C.; North Carolina State Univ. (1971). 76p. University Microfilms Order No. 72-10,101.

Thesis.

The threshold for the $^{36}Ar(p,n)^{36}K$ reaction was found to be 14.002 ± 0.024 MeV by using a chopped proton beam and measuring the positron activity during beam-off periods as a function of proton energy, positron energy, and time. The $^{36}Ar(^3He,t)^{36}K$ reaction was observed at 22.17 MeV, and a Q-value of −12.93 ± 0.04 MeV deduced. These two determinations provide the first ^{36}K mass measurements and lead to a value of −17.38 ± 0.03 MeV for the ^{36}K mass excess. Excited states in ^{36}K were observed at 0.800 ± 0.015, 1.115 ± 0.015, 1.59 ± 0.02, 1.67 ± 0.02, 1.89 ± 0.02, 2.27 ± 0.02, 2.41 ± 0.03, 2.56 ± 0.03, 2.85 ± 0.03 and 3.35 ± 0.04 MeV using the $^{36}Ar(^3He,t)^{36}K$ reaction. The positron activity following the $^{36}Ar(p,n)^{36}K$ reaction was also used to determine the ^{36}Ar half-life to be 341 ± 6 ms. An 80 cc Ge(Li) detector was used to study the gamma rays arising from the decay of ^{36}K using an 18-MeV chopped proton beam via $^{36}Ar(p,n)^{36}K$ reaction. The relative intensities of nine gamma rays with energies of 1969.8 ± 0.5, 2171.5 ± 0.9, 2208.3 ± 0.4, 2433.7 ± 0.4, 2472.0 ± 0.8, 4180.4 ± 1.0, 4441.7 ± 0.6, 4643.7 ± 1.4, and 6612.7 ± 0.8 keV were used to deduce positron branching ratios of 46%, 11%, and 43% to ^{36}Ar levels located at 1970.0 ± 0.4, 4441.7 ± 0.7, and 6612.9 ± 0.6 keV, respectively. Chopped proton beams were used to measure the excitation curve for the $^{36}Ar(p,n)^{36}K$ reaction between threshold and 30 MeV by observing the positron activity during beam-off periods. (Diss. Abstr. Int., B)

32335 SHELL-MODEL CALCULATIONS FOR ^{28}Si. Behrman, R. H. (McGill Univ., Montreal). Can. J. Phys.; 50: No. 1, 19-22(1 Jan 1972).

A spherical-shell-model calculation is performed for ^{28}Si in which up to 3p–3h excitations in the 2s–1d major harmonic-oscillator shell were included. A good account is given of the observed electromagnetic and β-decay data, although only fair agreement between the shell model and experimental spectra is obtained. (auth) (Canada)

32336 STRUCTURE IN THE PHOTONEUTRON CROSS SECTION OF ^{24}Mg AND ^{26}Mg. Ishkhanov, B. S.; Kapitonov, I. M.; Lazutin, E. V.; Piskarev, I. M.; Shevchenko, V. G. (Moscow State Univ.). Nucl. Phys.; A186: No. 2, 438-48(1972).

With bremsstrahlung from a 35 MeV betatron, the $^{24,26}Mg(\gamma, xn)$ reaction cross sections are obtained. The role of various factors in the formation of the giant resonance in ^{24}Mg and ^{26}Mg is considered. (auth)

32337 SHELL-MODEL CALCULATIONS FOR MASSES 27, 28, AND 29: ELECTROMAGNETIC TRANSITION RATES AND MULTIPOLE MOMENTS. De Voigt, M. J. A. (Rijksuniversiteit, Utrecht); Glaudemans, P. W. M.; De Boer, J.; Wildenthal, B. H. Nucl. Phys.; A186: No. 2, 365-78(1972).

Electromagnetic transition probabilities, multipole moments and log ft values have been calculated from many-particle shell-model wave functions in a truncated $1d_{5/2}$ $2s_{1/2}$ $1d_{3/2}$ configuration space, with a maximum of four holes in the $1d_{5/2}$ subshell. The electric quadrupole transition strengths and moments are reproduced very well in a least-squares fit to 74 experimental data with one parameter, for the isoscalar effective charge, yielding the values $e_p = 1.6$ e and $e_n = 0.6$ e. The results for magnetic dipole transition strengths and moments follow from adjusting two effective reduced single-particle matrix elements in separate least-squares fits to 17 experimental data in A = 27 nuclei and 21 data in A = 29 nuclei. The average absolute deviations between theory and experiment for E2 and M1 transition strengths are 3.0 and 0.05 W.u., while the average measured strengths are 7.7 and 0.08 W.u., respectively. Transitions from excited states above $E_x = 4.8$ MeV in ^{27}Al and from some low-lying states in ^{27}Al and ^{28}Si are poorly reproduced by the present model. Calculated strengths of transitions from analogue states are given. Previous conclusions about the single-particle character of M1 transitions and the collective behavior of E2 transitions are confirmed. The experimental data of seven A = 27–29 nuclei are well reproduced in one general treatment with an appreciably lower number of free parameters than are required to obtain comparable results in collective model calculations. (auth)

32338 THERMAL NEUTRON CAPTURE CROSS SECTION MEASUREMENTS AT THE NPL. Ryves, T. B. (National Physical Lab., Teddington, Eng.). pp 139-44 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

The 3-MV Van de Graaff accelerator at the NPL was used to produce sources of fast neutrons through the ^{9}Be(d,n)^{10}B reaction, which were moderated in a large graphite block, to give a standard thermal neutron flux. This flux was easily controlled in the range 10^4 to 3×10^7 n cm^{-2} s^{-1} and was reproducible to ±0.1 percent over a period of six months. The standard flux was used to measure thermal-neutron capture cross-sections and resonance integrals by the activation method, using $4\pi\beta$ gas-flow proportional counters to assay the activity. The main experimental problem was to measure the β counting efficiency of the foil samples; the β–γ coincidence technique was used when possible. A table of about thirty cross-section measurements is presented. These cross-sections were measured relative to gold. The errors were found conservatively, by adding linearly the estimated systematic errors and the random errors calculated at a 99% confidence level. The most accurate measurements are for ^{23}Na, ^{27}Al, ^{37}Cl and ^{51}V, with errors of approximately ±1 percent. The thermal neutron capture cross section for ^{23}Na is compared with a number of other measurements from the literature, and the spread in the results illustrates the present uncertainty which exists, even for a particularly favourable material. Sodium is an important reference material, because it can be combined easily with so many other elements to form highly pure salts, and could serve as the standard for many accurate cross-section measurements employing sodium compounds. (9 references) (auth)

32339 INVESTIGATION OF GAMMA-RAY DECAY PROPERTIES OF RESONANCE STATES OF ^{24}Mg. Lockwood, Loren Alan. Lawrence, Kan.; Univ. of Kansas (1971). 154p. University Microfilms Order No. 72-11,767.

Thesis.

Resonance states of ^{24}Mg between 13 and 15 MeV excitation energy decay predominantly by the emission of a proton or an alpha-particle, leaving ^{23}Na or ^{20}Ne, respectively, as the residual nucleus. Most resonances in this energy range are broad and overlapping. The particle decay properties of these states have been studied by various investigators, with varying degrees of energy resolution. To date, however, none has studied the de-excitation by gamma-ray emission of such highly excited resonance states of ^{24}Mg. In the present work, targets of ^{23}Na were bombarded with protons of energy between 1.7 and 3.0 MeV; gamma radiation was detected by a NaI(Tl) scintillation detector having good sensitivity and by a lithium-drifted germanium detector having good energy resolution. Twelve resonances were found which exhibited significant decay by gamma-ray emission. All are relatively narrow and apparently isolated. The precise energies of ten of the resonances, their total widths, and their absolute strengths were measured with thick targets. The decay schemes and branching ratios of the resonance states and the angular distributions of their higher-energy decays were measured with thin targets to reduce interference from fluorine contamination. Three of the resonances were assigned spin and parity with reasonable certainty. On the basis of the partial radiative widths for M1 transitions observed in their decays, two of the resonances appear to be isobaric analogs of states in ^{24}Na and ^{24}Al. Two other resonance states appear to be predominantly of isobaric spin zero. (Diss. Abstr. Int., B)

32340 PROTON ENERGY AND ANGULAR DISTRIBUTIONS FROM (n,p) REACTIONS ON ^{32}S, ^{59}Co, AND ^{58}Ni AT $E_n = 14.1$ MeV. Alvar, Kenneth Roger. Providence; Brown Univ. (1971). 154p. University Microfilms Order No. 72-8079.

Thesis.

A study has been made of proton energy and angular distributions from (n,p) reactions on ^{32}S, ^{59}Co, and ^{58}Ni for 14.1 MeV neutrons. The proton distributions were measured in 20° intervals from 0° to 120° lab. The data have been collected for the ^{32}S and ^{59}Co reactions for the first time using particle discrimination to eliminate deuterons from the yield. For each reaction the energy spectrum was fit with various statistical theory formulae to extract the nuclear temperature and level density parameter. The temperature was compared with a parameter τ which was calculated from the known level structure of the residual nucleus. The level density parameter was compared to the result from an empirical formula. The (n,p) and (n,np) total cross sections were calculated and compared to activation analysis results. In all cases rough agreement was found. The spin cut-off factor of ^{58}Co was estimated for the first time to be ≥1. The angular distributions indicated possible direct contributions and these were estimated and compared to the results of the theory of Brown and Muirhead. Close agreement is found only for the ^{58}Ni reaction. The use of the statistical theory in light of possible large direct contributions, while giving the agreement noted above, is questionable. The resolution of this apparent contradiction awaits further theoretical work. (Diss. Abstr. Int., B)

32341 OBSERVATION OF TWO-HOLE STATES BY THE ^{39}K(^{3}He,alpha)^{38}K REACTION. Fenton, Jeffrey Arthur. New Brunswick, N. J.; Rutgers–The State Univ. (1971). 163p. University Microfilms Order No. 72-9618.

Thesis.

^{38}K states up to 7.13 MeV excitation have been studied using the 21 MeV ^{3}He^{++} beam of the Rutgers-Bell Van de Graaff and the ^{39}K(^{3}He,α) reaction. The α's were analyzed by an Enge split-pole spectrograph equipped with a counter telescope arrangement of proportional counters for position and energy loss measurement. Absolute cross sections have been measured for 15 states. Several of the observed pickup angular distributions have a characteristic d wave shape, others have a characteristic s wave shape, and still others have a mixed s and d wave shape. Two appear to have f wave shapes. Optical model calculations were performed using published ^{3}He and α parameters. Only parameter sets which reproduced the ground state (^{3}He,α) angular distribution, assumed to proceed via pure $d_{3/2}$ pickup, were used for extraction of spectroscopic factors. Comparison of the spectroscopic factors obtained in the present analysis has been made with published results. Some discrepancies, particularly in parity assignments, are discussed. The observed states and their spectroscopic factors are discussed in the light of the sum rules and theoretical predictions. An interpretation of the extracted spectroscopic factors in terms of shell model wave functions for ^{38}K is presented. Several levels (presumably T = 0) below 7.13 MeV not previously observed in single nucleon pickup leading to A = 38 nuclei have been included in the present analysis. (Diss. Abstr. Int., B)

32342 PHOTONUCLEAR REACTIONS LEADING TO ^{24}Na AND ^{28}Mg. Saito, Tatsuya; Nomura, K.; Kato, T. (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 3: No. 2, 103-17 (Dec 1970).

Photonuclear reaction yields of ^{24}Na and ^{28}Mg in magnesium, aluminium, silicon, phosphorus and sulfur were obtained at energies between 20 MeV and 250 MeV by the induced radioactivity method. The ^{12}C(γ,n)^{11}C yield was used as a standard for the beam monitor. The excitation curves of the reactions ^{27}Al → ^{24}Na, ^{28}Si → ^{24}Na, ^{30}Si → ^{28}Mg, ^{31}P → ^{24}Na, ^{31}P → ^{28}Mg, ^{32}S → ^{24}Na and ^{32}S → ^{28}Mg were obtained from the yields by the photon difference method. Each of these excitation functions indicates the peak in the 50-70 MeV energy range, except in the case of sulfur target, and the peak is due to the contribution from compound nucleus process. In the energy range from 70 MeV up to 150 MeV, the cross sections are due to the contribution from the quasideuteron process. At energies above 150 MeV up to 250 MeV, the quasideuteron and pion production processes are competing. (auth) (Japan)

Nuclear Properties and Reactions, 39 ≤ A ≤ 58

Refer also to abstracts 31694, 32005, 32329, 32338, 32340, 32364, 32372, 32373, 32386, 32388, and 32429.

32343 (COO-3058-11) LINEAR ACCELERATOR PROJECT. Progress Report, October 1–December 31, 1971. (Rensselaer Polytechnic Inst., Troy, N. Y.). 1971. 57p. Dep. NTIS.

- ALUMINUM ALLOYS AND SYSTEMS—Al–Fe, fast neutron spectra in two-region, p. 39–41
- IRON—neutron total cross section at 20 to 400 keV, analysis of minima in, (E), p. 2–9
- NEUTRON SPECTROMETERS—resolution function for time-of-flight, p. 46–48
- URANIUM—neutron transmission and self-indication ratio measurements for depleted, p. 27–35
- URANIUM-238—neutron total cross section at 0.5 to 30 MeV, (E), p. 14–23 (J.W.R.)

32344 (FRNC-TH-153) SPECTROSCOPIC STUDIES OF THE ^{46}Ti NUCLEUS. Guillaume, Georges (Strasbourg Univ. (France)). 1971. 100p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The angular momenta, level parities and values for the multipolar mixing of the electromagnetic transitions were determined by analyzing the angular distributions and linear polarization of the γ rays emitted by the first seven excited levels of ^{46}Ti aligned by the ^{46}Ti(p,p′) reaction at 5.5 MeV. The angular distribution measurements also enabled branching ratios to be attributed to all of these levels. Linear polarization measurements utilizing the Compton effect required only one Ge(Li) detector. The experimental results are compared with theoretical predictions made using an $(f_{7/2})^6$ configuration model. Other configurations are suggested for states, which are not described by the model. Analysis of the three resonance γ spectra in the excitation function of the ^{45}Sc(p,γ) reaction at 917 and 1066 keV led to values for the excitation energies of 42 bounds levels of ^{46}Ti and to the branching ratios of the electromagnetic de-excitation of these levels and the resonance levels. (France)

32345 MEASUREMENTS OF THE TOTAL-NEUTRON CROSS-SECTION MINIMA IN NATURAL IRON. Rahn, F.; Camarda, H.; Hacken, G.; (and others) (Columbia Univ., New York). Nucl. Sci. Eng.; 47: No. 3, 372-5(Mar 1972).

Transmission measurements on natural iron samples were carried out at the Nevis Synchrocyclotron to determine the minima in the total cross section occurring between 10 and 500 keV. The NVS 200-m time-of-flight system with an effective fwhm resolution of ~0.6 nsec/m was used for these measurements. Values of the total cross section at the minima points were determined by the transmission-of-the-difference method for four thick samples ranging in inverse thickness (1/n) = 1.53 to 0.38 b/atom. The value of the cross section at the important minimum at 24.4 keV is (0.51 ± 0.02) b. This value is close to the one appearing in the KEDAK data file (0.557 b), but considerably higher than the values in ENDF/B-I (0.15 b) and ENDF/B-II (0.285 b) files. The value is in agreement with recent integral spectral measurements at RPI which show a preference for a value close to the KEDAK evaluation. (auth)

32346 STUDY OF THE ^{50}V NUCLEUS WITH THE (^{3}He,d), (^{3}He,α), (^{3}He,p), AND (^{3}He,pγ) REACTIONS. Smith, James William. Bloomington, Ind.; Indiana Univ. (1971). 177p. University Microfilms Order No. 72-10,006.

Thesis.

The nucleus ^{50}V with a ground-state configuration $(\pi f_{7/2})^3(\nu f_{7/2})^{-1}$ has been studied with the ^{49}Ti(^{3}He,d)^{50}V, ^{51}V(^{3}He,α)^{50}V, ^{48}Ti(^{3}He,p)^{50}V, and ^{48}Ti(^{3}He,pγ)^{50}V reactions induced by the ^{3}He^{++} beam from the tandem Van de Graaff at the Argonne National Laboratory. The angular distributions from (^{3}He,d), (^{3}He,α), and (^{3}He,p) reactions induced by 22-MeV ^{3}He were studied with overall energy resolution widths of 20, 30, and 42 keV, respectively. The reactions (^{3}He,p) and (^{3}He, pγ) were also studied at an incident energy of 13 MeV to obtain the γ decay of ^{50}V levels (including two 0^+ isobaric analog states) in which the neutron-proton pair is transferred with zero angular momentum. The angular distributions of the charged-particle reactions have been analyzed with the distorted-wave Born approximation (DWBA), and spectroscopic factors have been extracted for the one-nucleon transfer reactions. The two-nucleon transfer reaction (^{3}He,p) has been analyzed with the DWBA on the assumption that the neutron-proton pair is transferred as a deuteron. The angular momentum L_{np} of the transferred deuteron is established for most of the levels, and the possibility that several levels might have spin and parity 1^+ is discussed. This work has resulted in the assignment of $J^\pi = 1^+$ to levels at 1.333 and 1.490 MeV and supports the previous tentative spin assignments of 5^+, 4^+, 3^+, and 2^+ for the first four excited states. Seven states—these four states and the 6^+ ground state, the 7^+ state at 0.911 MeV, and the 1^+ state at 1.333 MeV—are identified as members of the $(\pi f_{7/2})(\nu f_{7/2})^{-1}$ octet. The γ decay of the two 0^+ isobaric analog states is observed to proceed by M1 transitions to low-lying states. The decay of several levels between 1.3 and 4 MeV excitation energy (some of them being possible candidates for a collective 1^+ excitation) are seen to decay in part to the same levels that are populated by decay of the two 0^+ analog states. Two models are evaluated with respect to the known data: (1) the truncated $1f_{7/2}$ shell model of McCullen, Bayman, and Zamick (MBZ) and (2) the rotational particle coupling (RPC) model of Wasielewski and Malik. The MBZ model predicts the energy levels and allows the calculation of spectroscopic factors which may be compared with experimental data. The results of the RPC model can be compared only with the experimental energy levels at this time. (Diss. Abstr. Int., B)

32347 HYPERFINE STRUCTURE INVESTIGATION OF THE EXCITED 4 $^2P_{3/2}$-STATE OF ^{39}K AND ^{41}K BY MODIFIED ATOMIC BEAM MAGNETIC RESONANCE. Boroske, E.; Zimmermann, D. (Technische Univ., Berlin). pp 417-19 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

The following modification of the method of D. Zimmerman (Z. Phys., 224: 403(1969)) was used: atoms of an atomic beam of potassium were polarized by optical pumping with circular polarized light of the potassium D lines and then analyzed with respect to their effective magnetic moments by a strong inhomogeneous Stern–Gerlach field; the resonance region for inducing transitions consisted of two different homogeneous magnetic fields, each containing a separate rf loop connected with a suitable rf oscillator. Hyperfine splitting constants determined were in good agreement with more precise values obtained by Ney (1969) using level-crossing techniques; nuclear electric quadrupole moments derived from the results are: $Q(K^{39}) = (6.1 \pm 1.3) \times 10^{-26}$ cm^2 and $Q(K^{41}) = (6.3 \pm 1.8) \times 10^{-26}$ cm^2. (L.M.T.)

32348 ^{58}Ni(n,p)^{58}Co AND ^{54}Fe(n,p)^{54}Mn CROSS SECTION MEASUREMENTS FOR USE AS THRESHOLD DETECTORS. Paulsen, A.; Widera, R. (Central Bureau for Nuclear Measurements, Geel, Belgium). pp 129-37 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

For the reactions ^{58}Ni(n,p)^{58}Co and ^{54}Fe(n,p)^{54}Mn experimental cross-sections were determined using the activation technique. By means of the 3-MV Van de Graaff accelerator of the CBNM, monoenergetic neutron cross-sections were measured in the 1 to 6 and 12 to 17 MeV energy regions. The results are compared with existing data within the framework of complete cross-section compilations. An analytical representation of (n,p) and (n,α) threshold reaction cross-sections as a function of neutron energy is derived from nuclear statistical theory and is fitted to the experimental data. The best values for the parameters are given, together with the resulting best values for the fission neutron average cross-sections and the effective thresholds. (48 references) (auth)

32349 L/K-CAPTURE RATIO OF ^{48}V. Bertmann, U.; Krahn, F.; Huster, E. (Univ., Muenster, Ger.). Z. Phys.; 251: No. 5, 382-6(1972). (In German).

The L/K capture ratio of ^{48}V for all transitions was measured simultaneously and $P_L/P_K = 0.104 \pm 0.004$ was found. Coincidence measurements with the γ-rays by scintillation counters led to $P_L/P_K = 0.115 \pm 0.015$. This latter value is not very exact, but the comparison of the number of K-pulses in the two sets of measurements shows that the ^{49}V impurity in the ^{48}V was less than 1.1% at the time of delivery and less than 10% during the measurements. So a possible ^{49}V impurity did not disturb the results. (auth)

32350 ^{58}Ni(^{3}He,p)^{60}Cu REACTION. Perazzo, R. P. J. (Univ. of Minnesota, Minneapolis. CNEA-Ciclotron, Buenos Aires). Nucl. Phys.; A186A: No. 2, 379-92(1972).

A shell-model description of ^{58}Ni and ^{60}Ni, ^{60}Cu and ^{60}Zn is attempted on the basis of an inert ^{56}Ni core and two or four valence particles moving in the $p_{3/2}$, $f_{5/2}$ and $p_{1/2}$ shells. The shell-model space is restricted to the lowest-seniority configurations. Energy eigenvalues and angular distributions for the reaction ^{58}Ni(^{3}He,p)^{60}Cu are obtained and compared with available experimental data. (auth)

32351 L/K-CAPTURE RATIO OF ^{49}V. Krahn, F. (Univ., Muenster, Ger.). Z. Phys.; 251: No. 5, 375-81(1972). (In German).

It is confirmed experimentally that the assumption of Heuer and

Huster that the underground pulses in electron capture spectra are caused by incompletely amplified K- and L-pulses and that therefore their method to evaluate the spectra is in its principle right. Further, the L/K-electron capture ratio of ^{49}V, which was not measured before, was studied. ^{49}V decays to the ground state of ^{49}Ti, and the capture ratio measured is $P_L/P_K = 0.106 \pm 0.004$. This result and other experimental values by several authors on elements with $18 \leqq Z \leqq 36$ are compared with the results of different theoretical evaluations. (auth)

32352 INTERPRETATION OF ^{57}Co LEVELS BY THE PARTICLE-CORE INTERACTION. Dayras, R.; Cujec, B. (Univ. Laval, Quebec). Nucl. Phys.; A186: No. 2, 307-20(1972). (In French).

The experimental data for ^{57}Co are interpreted on the basis of the particle-core coupling model. The core is assumed to be ^{56}Fe (in the ground and the excited states), and the particle (proton) states taken into account are: $1f_{7/2}$, $2p_{3/2}$, $2p_{1/2}$ and $1f_{5/2}$. The energy levels, spectroscopic factors, and γ-ray transition probabilities and mixing ratios for the first nine levels are fitted quite well with the model. (auth)

32353 HIGH RESOLUTION STUDY OF PROTON RESONANCES IN ^{47}V, ^{49}V, AND ^{51}V. Prochnow, Neal Harrold. Durham, N. C.; Duke Univ. (1971). 205p. University Microfilms Order No. 72-11,119.

Thesis.

Differential cross sections were measured for ^{46}Ti(p,p), ^{46}Ti[p,p$_1$], ^{48}Ti(p,p) and ^{48}Ti[p,p$_1$] at laboratory angles of 160°, 135°, 105° and 90° for proton energies of between 1.8 and 3.1 MeV. In addition a limited amount (~150 keV) of ^{50}Ti(p,p) data were taken near $E_p = 2.5$ MeV. These data were taken using the high resolution electrostatic analyzer-homogenizer system in the 3 MV Van de Graaff laboratory, which is a part of the Triangle Universities Nuclear Laboratory. Thin targets of enriched isotope were used and the observed energy resolution was 250–350 eV. The resonances observed in these excitation functions were analyzed in terms of parameters of the R-matrix theory. Spins, parities, total widths and partial widths were determined for a total of 481 resonances (J ranging from $\frac{1}{2}$ to $\frac{5}{2}$). Nine analog states were identified. In general the analog states are not highly fragmented; two of the analog states exhibit the asymmetric enhancement expected for the fine structure of isobaric analog states. For one of the analog states, a very high correlation between the elastic channel reduced widths and the inelastic channel reduced widths was observed. For levels with the same J^π off the analog, a very low correlation was observed. Spectroscopic factors were determined by three methods for all the analog states identified and compared with spectroscopic factors of the parent states. Reasonable agreement is obtained for five of the analog states (those with a total observed width much greater than the average observed width for the $T_<$ states). Coulomb energy differences between the analogs and their parent states were extracted, yielding results consistent with those of other experiments. Statistical properties of the resonances in ^{47}V and ^{49}V were examined. Detailed quantitative analysis shows that the level spacing and reduced width distributions (with energy dependence, missing levels, spin assignment ambiguities and analog state effects taken into consideration) are in reasonable agreement with the Wigner and Porter–Thomas distributions, respectively. Overall average values of the proton strength functions were determined from the reduced widths of the $T_<$ levels, for both the (p,p) and [p,p$_1$] data. For ^{49}V the $\frac{1}{2}^+$ local average strength function was found to increase with energy, while the $\frac{1}{2}^-$ local average strength function was found to decrease with energy. (Diss. Abstr. Int., B)

32354 PERTURBED ANGULAR CORRELATION STUDIES OF HYPERFINE FIELDS AT IMPURITIES IN FERROMAGNETS AND THE g-FACTOR OF THE 3.19 MeV 6^+ STATE IN ^{42}Ca. Marmor, Michael. Stony Brook, N. Y.; State Univ. of New York (1972). 114p. University Microfilms Order No. 72-12,788.

Thesis.

Perturbed angular correlation experiments have been performed to obtain information on hyperfine fields at impurities in ferromagnets and on nuclear structure. The time-differential technique has been used to measure the fields at ^{42}Ca in Fe and Co yielding values of -95 ± 8 kG and -67 ± 11 kG, respectively; data have been obtained for the field at ^{42}Ca in Ni which are consistent with $|H_{hf}| \lesssim 50$ kG. The time-integral technique has been used to measure the g-factor of the 6^+ state in ^{42}Ca resulting in a value of -0.42 ± 0.04; the average of this result and a recent result of Nomura et al., of -0.50 was used to extract the above hyperfine fields from the measured Larmor precession frequencies in the various ferromagnetic metals. The field at ^{41}K in Fe has also been measured by the time-differential PAC technique yielding a value of -157 ± 20 kG. The hyperfine field at ^{19}F in Ni has been remeasured to be 17.7 ± 0.7 kG. This experiment was performed as a preliminary to an attempted measurement of the field at ^{19}Ne in Ni which used the isobaric analog of the state used in the ^{19}F investigation. The results of the ^{19}Ne experiment did not yield a definite Larmor frequency. An attempt was also made to perform an internal field PAC measurement using the 3^+ state at 0.417 MeV in ^{26}Al, with similar indefinite results. The measured hyperfine fields at ^{42}Ca and ^{41}K in Fe have been compared to the predictions of Balabanov and Delyagin and those of the theory of hyperfine fields of Daniel and Friedel, as modified by Campbell. Both results are in disagreement with the former theory, while the ^{42}Ca result is in good agreement with the latter, but the ^{41}K result is in fairly poor agreement with that theory. Information has been obtained on the problem of loss of alignment for light nuclei in ferromagnets. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, $59 \leq A \leq 89$

Refer also to abstracts 32329, 32340, 32348, 32350, 32364, 32367, 32372, 32373, 32388, and 32429.

32355 (JINR–P7-6316) ANGULAR DISTRIBUTIONS OF NEUTRONS PRODUCED IN BOMBARDING THE Ge, Mo, Ag, Pr TARGETS BY HEAVY IONS OF C, O, Ne, Ar. Il'inov, A. S.; Karamyan, S. A.; Nguyen Tak An; Sharifov, K. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

Angular distributions are measured for the neutrons emitted in inelastic interactions of ^{12}C, ^{16}O, ^{22}Ne, ^{40}Ar heavy ions with ^{73}Ge, ^{96}Mo, ^{108}Ag, ^{141}Pr nuclei. The results are compared with calculations performed on the basis of the statistical model of nuclear reactions. It is shown that the neutrons, evaporated in de-excitation of the compound nuclei, give the main contribution to the angular distributions. (auth)

32356 DECAY OF ^{68}Ga$_{37}$. Slot, W. F.; Dulfer, G. H.; Van Der Molen, H.; Verheul, H. (Vrije Univ., Amsterdam). Nucl Phys.; A186: No. 1, 28-32(1972).

The decay of ^{68}Ga to ^{68}Zn was studied with a double-focusin β-spectrometer. The measured endpoint energy of the highe β-branch is 1.8991 ± 0.0012 MeV. Conversion electrons of the 1.6559 MeV $0^+ \rightarrow 0^+$ transition were observed. The relative intensity of the E_0 transition is 0.010 ± 0.002 if the intensity of the conversion electrons due to the 1.0775 MeV transition equals 1. Measured energies and relative intensities of the γ-rays were found to be in reasonable agreement with the results of other authors. (auth)

32357 DECAY OF ^{86m}Y. Simpson, M. L.; Kitching, J. E.; Mark, S. K. (McGill Univ., Montreal). Nucl. Phys.; A186: No. 1, 171-6(1972).

The decay of the 8^+, 218.4 keV isomeric state of ^{86}Y has been re-investigated. It was observed that this state decays with a weak β^+ branch to a state at 2955.5 keV in ^{86}Sr as well as γ-decaying to states in ^{86}Y. The relative β^+ decay strength was measured to be (0.69 ± 0.04)%, corresponding to a log ft value of 6.51. Gamma-gamma coincidence measurements indicated that the 2955.5 keV state undergoes four successive cascade transitions to the ground state of ^{86}Sr with the emission of γ-rays at 98.6 ± 0.1, 627.2 ± 0.2, 1076.6 ± 0.3 and 1153.1 ± 0.3 keV. A new decay scheme is proposed. (auth)

32358 INTERNAL CONVERSION ELECTRON SPECTROSCOPY OF THE ^{75}As(p,n)^{75}Se AND ^{73}Ge(p,n)^{73}As REACTIONS. Linn, Joseph Ralph Jr. New Orleans; Tulane Univ. (1971). 96p. University Microfilms Order No. 72-3896.

Thesis.

The internal conversion coefficients of transitions between the low levels of ^{75}Se and ^{73}As populated in the ^{75}As(p,n)^{75}Se* and the ^{73}Ge(p,n)^{73}As* reactions were measured with an in-beam spectrometer at $E_p = 3.0$ MeV. The values of α_K for ^{75}Se are: 112 keV: $(10.0 \pm 3.0) \times 10^{-2}$; 141 keV: $(4.5 \pm 1.5) \times 10^{-2}$; 287 keV: $(3.7 \pm 1.7) \times 10^{-3}$; 377 keV: $(4.1 \pm 1.3) \times 10^{-3}$. The values of α_K for ^{73}As are 181 keV: $(1.37 \pm 0.27) \times 10^{-2}$; 254 keV: $(7.65 \pm 1.7) \times 10^{-3}$; 361 keV: $(1.54 \pm 0.16) \times 10^{-2}$; 510 keV: $(6.0 \pm 2.1) \times 10^{-4}$. Ge(Li) singles measurements of gamma-rays in ^{73}As were made, and transition energies and relative intensities were obtained for 29 γ rays. The low-energy level structure of ^{75}Se and ^{73}As is compared with recent experimental results and theoretical predictions. A table of interpolated theoretical ICC for Z = 33 and 34 is presented. (Diss. Abstr. Int., B)

32359 RESEARCH ON (n,α) REACTIONS WITH 14 MeV NEUTRONS ON THE TARGET NUCLEI ^{63}Cu, ^{93}Nb, ^{103}Rh, ^{107}Ag, ^{127}I, AND ^{133}Cs. Bormann, M.; Schmidt, W.; Schroeder, V.; Scobel, W.; Seebeck, U. (Univ., Hamburg). Nucl. Phys.; A186: No. 1, 65-87(1972).

The angular distributions and energy spectra of α-particles from neutron induced reactions have been measured at E_n = 14.2 MeV for the target nuclei ^{63}Cu, ^{93}Nb, ^{103}Rh, ^{107}Ag, ^{127}I and ^{133}Cs. The measured quantities can consistently be divided into contributions from direct and compound nuclear mechanisms. The ratio of these contributions as a function of the target mass number A is discussed. The compound parts of the reactions can be interpreted in terms of the statistical model using the Fermi gas model approximation for the level density and optical-model absorption cross sections. The deduced values for the level density parameter a and the spin cut-off parameter σ are compared with existing systematics and theoretical predictions. (auth)

32360 ELECTRON SCATTERING ON ODD-MASS NUCLEI DESCRIBED BY PARTICLE-PHONON AND PARTICLE-CORE MODELS: APPLICATION TO ^{63}Cu. De Jager, J. L; Boeker, E. (Vrije Univ., Amsterdam). Nucl. Phys.; A186: No. 2, 393-416(1972).

Some odd-mass nuclei are described well by particle-phonon and particle-core coupling models. With a few assumptions, and introducing effective operators in the formula of the differential cross section for electron scattering in the Born approximation, the form factors are calculated in a rather simple way. In the case of ^{63}Cu, it becomes clear that measurements of the inelastic form factors can be a sharp test on these coupling models. (auth)

32361 ELASTIC SCATTERING OF NUCLEONS FROM TARGETS WITH SPIN. Chen, Cary. Athens, Ohio; Ohio Univ. (1971). 119p. University Microfilms Order No. 72-9575.

Thesis.

Up to now there is a lack of analytical work done in the field of elastic scattering of nucleons from targets with spin. The present investigation is an attempt to fill part of this void. In particular, this dissertation is a study of a class of well known reactions known as isobaric analog resonance reactions. The two reactions analyzed are ^{89}Y(p,p)^{89}Y and ^{115}In(p,p)^{115}In. From the studies of the compound states formed from these elastic scattering processes, it is possible to deduce certain properties of the analog states of the parent nuclei ^{90}Y and ^{116}In. The properties that one can extract from the analysis of the analog resonances are the energy levels, spins, parities and the partial and total widths of the nuclear states involved in the reactions. A computer program THORN was modified to do the calculation for the present investigation. The modification involved was the addition of the possibility of target spin and the inclusion of isolated resonances. For each resonance, contributions to the scattering amplitudes were composed of the Coulomb, optical and resonance terms. For a given reaction, differential cross section and polarization excitation functions were fitted by parameterization. After fitting the optical background, the parameters available for adjustments for each channel were the resonance energy, the partial and total widths, the resonance mixing phases and the relative phases. All comparisons between experimental and calculated values were plotted and judged visually. It was considered a good fit if the calculated values followed the overall shapes of the experimental data. The results of the investigation have lead to the following conclusions: (a) The 7.29 and 7.46 MeV levels in the ^{89}Y + p reaction are the analog states of the parent nucleus, ^{90}Y, the 2^- state at 2.48 and 1^- state at 2.63 MeV, respectively. These states in the ^{89}Y + p reaction can be described by a $d_{5/2}$ particle coupled to the $(1/2)^-$ target spin. Possible admixtures of $d_{3/2}$ and $s_{1/2}$ particle configurations in the 2^- and 1^- states respectively were found to be very small. (b) Six positive parity states of the ^{115}In + p reaction are determined to have $J^\pi = 5^+, 4^+, 5^+, 4^+, 3^+$ and 6^+ at the energies 6.91, 7.03, 7.12, 7.22, 7.30 and 7.46 MeV, respectively. These six states are likely from the couplings of the $(9/2)^+$ target spin to the $s_{1/2}$ and $d_{3/2}$ particles. A negative parity state with possible total spin assignment of $5^-, 6^-, 7^-$, or 9^- is at the energy 7.254 MeV. This level is likely from the coupling of the $(9/2)^+$ target spin to the $h_{11/2}$ particle. There is configuration mixing in the 4^+ and 5^+ states. The 4^+ states at 7.03 and 7.22 MeV and the 5^+ states at 6.91 and 7.12 MeV have configuration mixing of $s_{1/2}$ and $d_{3/2}$ single-particle states. The 3^+ and 6^+ levels appear to be relatively pure states of d waves. (c) A very useful partial width sum rule is presented and applied in the present study. This rule indicates that the sum of the channel partial widths is independent of the total spin of the state but dependent on the channel spin l_j only. Mathematically, it is stated as $\Sigma_{J_1}\Gamma_{l_j}^{J_1} = \Sigma_{J_2}\Gamma_{l_j}^{J_2}$ where $\Gamma_{l_j}^{J_1}$ and $\Gamma_{l_j}^{J_2}$ are the partial widths of the total spin J_1 and J_2, respectively. It is expected that this rule will help towards the identification of the total spin and the proper amount of partial width in a resonance state. (Diss. Abstr. Int., B)

32362 DECAY SCHEME STUDIES ON $^{74\ 76\ 78}$As. Morcos, Nabil Aziz. Fayetteville, Ark.; Univ. of Arkansas (1972). 101p. University Microfilms Order No. 72-10,214.

Thesis.

The decay schemes of arsenic 74, 76 and 78 were studied using a Ge(Li) spectrometer and β- and γ-ray scintillation detectors. Several γ-γ, γ-β and β-γ coincidence measurements were performed. Gamma-ray and β-ray intensities were measured. Spin and parity assignments were deduced for several excited levels in the daughter nuclei. The β-decay Q-value for each of the nuclei were also determined. Decay schemes are presented and discussed in terms of the more recent theoretical and experimental studies of the region. (Diss. Abstr. Int., B)

32363 NUCLEAR SPECTROSCOPIC STUDIES OF SOME SHORT-LIVED AND NEUTRON DEFICIENT Ga AND Zn ISOTOPES. Giesler, Gregg Carl. East Lansing, Mich.; Michigan State Univ. (1971). 204p. University Microfilms Order No. 72-8659.

Thesis.

The decay schemes of ^{63}Zn, ^{62}Zn and ^{63}Ga were investigated by high-resolution γ-ray spectroscopy in an effort to further elucidate their nuclear properties. Also, a search for β-delayed α emission from the light Ga isotopes was conducted. Such γ-ray spectroscopic techniques as Ge(Li) singles, Ge(Li) – Ge(Li) mega-channel coincidence, Ge(Li) – NaI(Tl) coincidence, and Ge(Li)-time coincidence techniques have been utilized to study these isotopes. A He-jet thermalizer was utilized in the search for β-delayed α emission. Several programs written for data analysis are presented. Forty-five γ rays have been assigned to the decay of 38.4-minute ^{63}Zn and have been incorporated into a decay scheme containing 24 levels with energies of 0, 669.71, 962.14, 1327.0, 1412.07, 1546.8, 1860.9, 1865.7, 2012.0, 2062.3, 2081.4, 2093.5, 2336.8, 2497.5, 2512.5, 2536.2, 2697.0, 2717.2, 2780.1, 2857.8, 2889.5, 3044.0, and 3100.3 keV. A search for γ rays with energies above 700 keV from the decay of 9.3-hour ^{62}Zn was conducted and six were found at energies of 881.4, 915.6, 1142.5, 1280.8, 1389.1, and 1429.9 keV. They were placed in a decay scheme containing seventeen γ-rays and ten levels with energies of 0, 40.94, 243.44, 287.98, 548.41, 637.53, 915.6, 1142.5, 1280.8, and 1429.9 keV. The decay of 32.4-second ^{63}Ga has sixteen γ rays which were placed in a decay scheme containing nine levels with energies of 0, 193.0, 248.0, 627.1, 637.0, 650.1, 1065.2, 1395.4, and 1691.7 keV. Spin and parity assignments for the nuclear states investigated are based on log ft values, relative γ-ray intensities to states of known spin and parity and charged particle scattering results. A survey of and comparison with previously reported Ge(Li) detector results and with charged particle scattering results is presented for these isotopes. The structures of the low-lying states in these nuclei are discussed and compared with theoretical calculations and systematics of the region. A search for β-delayed α emission from the short-lived (<5 sec) Ga isotopes through ^{60}Ga was conducted. The γ-ray and α-particle spectra from the nuclei produced are presented. An upper limit of ten parts per million was placed on β-delayed α branching from the decay of these nuclei. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, $90 \leq A \leq 149$

Refer also to abstracts 32005, 32338, 32348, 32355, 32359, 32361, 32386–32388, 32394, and 32429.

32364 (CEA-R-4296) GAMMA SPECTRA CATALOG (Ge–Li). Lefevre, Hubert; Godement, Annie; Repellin, Marie-Jeanne (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Feb 1972. 63p. (In French). Dep. NTIS (U. S. Sales Only).

The spectra of some thirty radioelements obtained by irradiating small quantities of natural isotopes (10 to 20 μg) in a reactor (2 to 8 days with a flux between 1 and 2×10^{13} n/cm^{2}s) were measured using a 37-cm^3 Ge(Li) semiconductor detector and a 4000-channel analyzer. (51 figures, 1 table) (auth)

32365 (JINR-P6-6285) INVESTIGATION OF THE DECAY OF ^{133}Pr (6.5 min). Arl't, R.; Baier, G.; Gromov, K. Ya.; Muziol, G.; Ortlepp, Kh. G.; Tyroff, Kh.; Usmanova, Z. A.; Shtrusnyi, Kh.; Kherrmann, E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The decay scheme ^{133}Pr → ^{133}Ce has been investigated using mass-separated sources. The internal conversion coefficients of a number of γ-transitions in ^{133}Ce have been determined. The first version of the decay scheme ^{133}Pr → ^{133}Ce was suggested. (auth)

32366 (JINR–P6-6313) EXPERIMENTS ON SEARCH FOR THE PROTON DECAY FROM THE GROUND STATE. Bogdanov, D. D.; Bochin, V. P.; Karnaukhov, V. A.; Petrov, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). [1972]. 28p. (In Russian). Dep. NTIS (U. S. Sales Only).

The neutron-deficient products from the reactions, induced by the accelerated ions of ^{32}S and ^{35}Cl in the targets of ^{96}Ru, ^{102}Pd, ^{106}Cd, ^{112}Sn, were studied. Using two techniques it is established that in bombarding ^{96}Ru by ^{32}S ions a proton emitter is produced having energy of 0.83 ± 0.05 MeV and half-life of about 1 sec. It is assumed that this group of protons appears in the decay of a light isotope of praseodymium (or lanthanum) for the ground state. (auth)

32367 (LYCEN–7184) STUDY OF (α,p) REACTIONS AT 42 MeV WITH ^{59}Co, ^{115}In, AND ^{116}Sn TARGETS. Pertosa, Pierre (Lyon Univ. (France). Institut de Physique Nucleaire). Dec 1971. 40p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Lyon Univ. (France).

The energy spectra obtained at different angles (20 to 150°) and the angular distributions of the protons emitted during the bombardment of ^{59}Co, ^{115}In and ^{116}Sn targets with 42 MeV α particles are presented. The Griffin model is used to analyze the hard component of the spectrum. The results obtained at 42 MeV enable the cross sections corresponding to evaporation mechanisms of the compound nucleus and the precompound nucleus to be evaluated and the verification of the energy independence of the principal parameter (n_i): initial number of excitons of the Griffin model to be made. The results obtained are normalized by comparison with the experimental results of West for ^{59}Co. Structure effects were studied for the high energy spectra of ^{116}Sn and ^{115}In. These effects result in different values for $n_i : n_i = 4$, $n = 5$, when the spectra are interpreted in terms of energy using the exciton model. (France)

32368 (ORO–3346-83) MEAN L-FLUORESCENCE YIELDS AND RELATIVE L X-RAY INTENSITIES IN THE REGION Z = 55 TO 65. Nix, Dale Wendel (Georgia Inst. of Tech., Atlanta). Mar 1972. Contract AT(40-1)-3346. 54p. Dep. NTIS.

Thesis.

The ratio of the intensity of the L x rays to that of the K x rays emitted from radioactive sources was determined experimentally by using Si(Li) and Ge(Li) detectors. From this ratio values of the mean L-shell fluorescence yield were determined for elements with Z = 55, 56, 57, 59, and 65. The ratio of the intensity of the $L_3-M_{4,5}$ x-ray transition to that of the L_3-M_1 transition was deduced from the L x-ray spectra in the region $55 \leq Z \leq 94$. A complete set of equations was developed to calculate the mean L-shell fluorescence yield and the primary vacancy distribution for the decay of any nuclide. (5 figures, 8 tables) (R.W.R.)

32369 (RLO–1388-164) POLARIZATION EFFECTS IN THE ISOSPIN-COUPLED REACTION CHANNELS p + ^{91}Zr AND n + ^{91}Nb$_{IAS}$. Cramer, J. G.; Preikschat, E.; Baker, M. P.; Hasinoff, M. D.; Roth, G. W.; Weitkamp, W. G. (Washington Univ., Seattle. Dept. of Physics); Braithwaite, W. J. (Princeton Univ., N. J. Dept. of Physics); Moore, C. Fred (Texas Univ., Austin. Center for Nuclear Studies). [1971]. 11p. Dep. NTIS.

The analyzing-power excitation functions for the reaction p + ^{91}Zr were measured at 150° in the energy range 10.0 to 14.9 MeV, which spans the thresholds of the (p,n) quasi-elastic and quasi-inelastic reaction channels leading to the production of the analogs in ^{91}Nb of the ^{91}Zr target ground state and $5/2^+$(1.46 MeV) excited state, respectively. A pronounced variation in the analyzing power is observed in the (p,d_0) exit channel at just the energy regions where charge-exchange coupling is expected to occur due to the opening of the quasi-elastic and quasi-inelastic channels. Somewhat less expected is the change in analyzing power observed in the elastic proton channel in the vicinity of the quasi-elastic and quasi-inelastic thresholds. The analyzing power for the (p,n$\bar{\text{p}}$) process was measured in this energy region and was found to be consistent with zero. (2 figures) (auth)

32370 RESONANCE WIDTHS AND UNITARITY. Tindle, C. T. (Univ. of Auckland, N. New Zealand). Can. J. Phys.; 50: No. 2, 84-92(15 Jan 1972).

The low energy neutron cross section of ^{135}Xe is analyzed using both the R-matrix theory of Wigner and Eisenbud and the S-matrix theory of Humblet and Rosenfeld. Particular attention is given to the role played by the total resonance level width for it is well known that the R-matrix widths are energy dependent but the S-matrix widths are not. This different energy dependence leads to different analytic forms for the cross section and the n + ^{135}Xe reaction offers what may be the simplest and best physical example for comparing these two forms. To the accuracy of the present data the difference is not detectable. The different energy dependence of the resonance widths is shown to be related to unitarity. A general proof that the R-matrix formalism is always unitary is given. The difficulty of satisfying unitarity in the S-matrix formalism is discussed and it is shown for the n + ^{135}Xe reactions that this can lead to physically unacceptable solutions. This "lack of unitarity" does not, however, lead to any difficulties in fitting the present experimental data. (auth) (Canada)

32371 PARTICLE-HOLE STATES IN ^{124}Sn EXCITED BY PROTON INELASTIC RESONANCE SCATTERING. Ali, S. S.; Zaidi, S. A. A.; Seitz, H. (Univ. of Texas, Austin). Nucl. Phys.; A186: No. 1, 152-60(1972).

The proton decay of the $f_{7/2}$ analog resonance in ^{124}Sn + p at E_p^{lab} = 10.614 MeV has been studied. Proton spectra from this experiment are compared to data from a recent (t,p) experiment on ^{122}Sn, which showed a number of strongly excited states at about 5 MeV excitation energy. These states in ^{124}Sn are also excited in the (p,p′) experiment, thus confirming the particle-hole structure, suggested in the (t,p) work. Decay widths, tentative spin assignments and spectroscopic factors are given. The level scheme of ^{124}Sn up to an excitation energy of 5.6 MeV is established. (auth)

32372 ACTIVATION CROSS SECTIONS OF FAST NEUTRON INDUCED NUCLEAR REACTIONS: PRECISION MEASUREMENTS AND SYSTEMATICS. Qaim, S. M.; Wolfle, R.; Stocklin, G. (Kernforschungsanlage, Juelich, Ger.). pp 121-8 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

Activation cross sections for six (n,2n) reactions induced by reactor fast neutrons and eighteen (n,2n), (n,p) and (n,α) reactions induced by 14.7-MeV neutrons were measured with maximum errors of 10 to 15% on isotopes of medium- and heavy-mass elements, with special reference to reactor materials. The mechanisms and systematics of these reactions are discussed. Cross sections for six (n,t) reactions at 14.7 MeV were also measured and a preliminary investigation of the systematics of this reaction is described. (19 references) (auth)

32373 MEASUREMENTS OF NUCLEAR DECAY SCHEMES. Goodier, I. W.; Woods, M. J.; Williams, A. (National Physical Lab., Teddington, Eng.). pp 175-80 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

Measurements of nuclear decay scheme parameters arising from work on standards of radioactivity are described. These include measurements of half-lives of some relatively short-lived radionuclides, with an assessment of their error, and determinations of the total internal conversion coefficients of ^{87m}Sr, ^{113m}In and ^{203}Hg. Measurements of the electron-capture-to-positron ratio in the decay of ^{22}Na and ^{58}Co are also described. (9 references) (auth)

32374 SOME HALF-LIFE MEASUREMENTS BY MASS AND GAMMA-RAY SPECTROMETRY. Cabell, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 189-97 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

An accurate knowledge of the half-lives involved is needed for (a) the assay of radioactive sources by direct counting, (b) the measurement of neutron capture cross sections by activation methods, and (c) the measurement of neutron flux using activation detectors. It is important, therefore, that the methods used for the measurement of half-lives should give results which are both precise and free from bias. A general method for treating decay data which is capable of giving results with these properties is described. It is then applied to the specific cases of the measurement of the half-lives of ^{198}Au and ^{148}Pm by gamma-ray spectrometry. Details of a mass spectrometric measurement of the half-life of ^{241}Pu are also given. The application of a similar technique to investigate the suggestion that freshly produced ^{241}Pu contains a 0.34-yr isomer is also described. It is concluded that, if such an isomer exists, it does not decay by direct β^- emission. The half-lives of ^{198}Au, ^{148}Pm and ^{241}Pu were found to be 2.6946 ± 0.0010 days, 5.370 ± 0.009 days and 15.16 ± 0.19 yr, respectively. (24 references) (auth)

32375 HIGH ENERGY PHOTONUCLEAR REACTIONS IN ^{141}Pr. Diefallah, El-Hussieny M. (Assiut Univ., Egypt). Int. J. Appl. Radiat. Isotop.; 23: No. 4, 153-6(Apr 1972).

High energy photonuclear reactions in ^{141}Pr were studied making use of the method of residual activity and γ ray scintillation spectroscopy techniques. The yield values of ^{140}Nd produced in irradiations of praseodymium oxide target were determined with bremsstrahlung of maximum energy varying from 100 to 300 MeV. The observed ^{140}Nd yields indicate that there is significant contribution from secondary proton reactions. (auth) (UK)

32376 ^{135}Ba AND THE CORE-EXCITATION MODEL. Parthasaradhi, K.; Lakshminarayana, V. (Andhra Univ., Waltair, India). Curr. Sci. (India); 41: No. 7, 250-1(5 Apr 1971).

An attempt was made to describe the low-lying levels of ^{135}Ba using the core-excitation model. The results are compared with experimental data. The predicted properties are in good agreement except for the energy of the $^{5}/_{2}$ state and the quadrupole moment of the ground state. (J.W.R.)

32377 DECAY STUDIES OF ^{98}Pd AND ^{98}Rh. Bakhru, H. (State Univ. of New York, Albany. Yale Univ., New Haven); Ladenbauer-Bellis, I. M.; Jones, B. Nucl. Phys.; A186: No. 2, 321-30(1972).

The decay properties of ^{98}Pd and ^{98}Rh have been studied using high-resolution Ge(Li) and Si(Li) counters. The analysis of the experimental data on these nuclei is impeded due to short half-lives and the various difficulties in preparation of clean sources. In the present work relatively clean sources of ^{98}Pd were produced via two reactions: ^{96}Ru(α, 2n)^{98}Pd and ^{89}Y(^{14}N, 5n)^{98}Pd. A half-life of 18.0 ± 0.5 min was measured for the following γ-rays: 67.7, 106.8, 112.5, 174.5, 386.0, 663.0, 725.7 and 837.9 keV. The nucleus ^{98}Rh was formed by the decay of ^{98}Pd as well as in the ^{89}Y(^{12}C, 3n) ^{98}Rh reaction. Quick chemical separations were performed to separate the Rh fraction. A half-life of 8.3 ± 0.2 min was established for the following γ-rays: 597.7, 625.6, 745.4, 762.3, 1164.4, 1414.9 and 1817.0 keV. The use of two Ge(Li) detectors in coincidence studies has revealed the presence of several previously unreported transitions. Based on γ-γ and β-γ coincidence results, consistent level schemes of ^{98}Rh and ^{98}Ru are given. The spin and parity assignments of some of the low excited levels are discussed. (auth)

32378 GAMMA RAYS FOLLOWING THE DECAY OF ^{112}In AND POPULATION OF THE 1225-keV O^{+} STATE IN ^{112}Cd. Sugiyama, K.; Kotajima, K.; Itagaki, S.; Takeda, Y. (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 3: No. 2, 38-47(Dec 1970).

The gamma rays following the decay of 14-min ^{112}In have been studied with a 24-cc Ge(Li) detector. The energy values and relative intensities of the gamma rays are: 606.4 ± 0.5 keV (23.4%), 618.2 ± 0.4 keV (100.0%), 1252.6 ± 0.9 keV (5.6%), 1278.0 ± 1.4 keV (0.2%), 1306.3 ± 1.7 keV (0.1%) and 1488.9 ± 1.3 keV (1.2%). The excited levels of ^{112}Cd at 618.2 keV, 1224.6 keV, 1306.3 keV, 1488.9 keV, 1870.8 keV and 2502.6 keV are considered to be 2^+, 0^+, 2^+, 2^+, 0^+ and 2^+, respectively. The population of the 1224.6-keV 0^+ state by beta feeding is qualitatively discussed. (auth) (Japan)

32379 ANALYSIS OF THE ^{91}Zr(p,t)^{89}Zr REACTION. Awaya, Takashi; Ohmura, Haruko; Lin, Ching Liang (Tokyo Univ.). J. Phys. Soc. Jap.; 32: No. 5, 1175-81(May 1972).

The analysis of the reaction has been done by using a zero-range DWBA with a new form factor. The interactions between the incident proton and each of the transferred neutrons were independently considered. Woods–Saxon wave functions were used for bound states of the transferred neutrons. These treatments made it possible to compare the absolute values of the calculated cross sections with the observed values. Spin assignments for the states in ^{89}Zr below 3 MeV were done. Strong enhancements seem to exist for the pair transitions to the states in ^{89}Zr which correspond to the ones in ^{90}Zr(p, t)^{88}Zr reaction. Possibility of the contribution of relative D-states between the transferred neutrons is discussed to interpret the discrepancies between the observed and calculated angular distributions for the one-hole states in ^{89}Zr. (auth)

32380 EXPERIMENTAL INVESTIGATION OF THE ^{91}Zr(p,t)^{89}Zr REACTION AT 51.7 MeV. Awaya, Takashi (Tokyo Univ.); Ohmura, Haruko; Ishimatsu, Toshiyuki; (and others). J. Phys. Soc. Jap.; 32: No. 5, 1169-74(May 1972).

The ^{91}Zr(p, t)^{89}Zr reaction has been studied by using 51.7-MeV protons in order to obtain information on the reaction mechanism. Emitted tritons were analyzed by a broad-range magnetic spectrometer with a 200-channel counter array. Angular distributions of the tritons were obtained for the thirteen states in ^{89}Zr. They were compared with the DWBA calculations in which a new formalism for form factors was used. Calculated patterns of the angular distributions for the lowest four one-neutron hole states in ^{89}Zr poorly fitted the experimental results in comparison with the case for the higher states. Absolute values of the observed cross sections for the former agreed with the calculated ones within a factor of 2 but were strongly enhanced for the latter. (auth)

32381 MAGNETIC DIPOLE MOMENTS OF VERY SHORT-LIVED NUCLEAR STATES BY THE RECOIL-INTO-GAS METHOD. Miller, Tom Richard. Stanford, Calif.; Stanford Univ. (1971). 130p. University Microfilms Order No. 72-11,621.

Thesis.

Measurements of magnetic dipole moments of very short-lived states in the nuclei ^{103}Rh, ^{107}Ag and ^{109}Ag have been performed with the recoil-into-gas method. Important general properties of this technique, relevant to the measurement of moments of states with lifetimes in the picosecond range, have been determined, and the g-factors for the low-lying $^{3}/_{2}{}^{-}$ and $^{5}/_{2}{}^{-}$ nuclear levels in the above nuclei have been measured. A beam of 50-MeV ^{35}Cl ions was used to Coulomb excite the nuclei and eject the entire target atom out of the thin target foil into a region which could be filled with helium gas of variable pressure. These atoms, highly ionized by passage through the foil, have extremely strong hyperfine magnetic fields of approximately 50 mega Gauss strength at the nucleus due to the strong contributions to the field from the unpaired electrons. The collisions of each ion with the gas molecules in the gas cell act to change the hyperfine field direction resulting in a randomly varying magnetic perturbation of the nuclear dipole moment. This perturbation is measured through observation of the change in the de-excitation gamma ray angular distribution from the unperturbed case, as observed in two Ge(Li) detectors fixed at 0° and 90° to the beam axis. The properties of the perturbation mechanism were studied through a comparison of experiments in which the nuclei were allowed to travel freely through the gas with experiments in which the nuclei were implanted, after traveling a short distance through the gas, in a copper stopper where there is no perturbation. It was determined that the hyperfine field strength $\overline{H}$ when averaged over a perturbation time of 18 psec while traveling through the gas before reaching the stopper was larger than the field strength when averaged over the lifetimes of the longer-lived rhodium and silver states in the unrestricted recoil case by a factor $\overline{H}$ (18 psec)/$\overline{H}$ (43, 50, 110 psec) = 1.45 ± 0.15. A declining field perturbation theory is suggested as a possible explanation of this new observation that the hyperfine field strength declines with time. For these nuclei the Dillenburg–Maris and Scherer–Blume theories, leading to only minor changes from the standard Abragam–Pound theory, were not useful in explaining this observation. When compared to predictions of the single-particle model of nuclear structure, all the measured g-factors lie close to the lower Schmidt line for odd-proton nuclei. The de-Shalit core-excitation theory was found to give predictions in rough agreement with the g-factors and their ratios $g(^{3}/_{2}{}^{-})/g(^{5}/_{2}{}^{-})$. (Diss. Abstr. Int., B)

32382 MEASUREMENT AND ANALYSIS OF COULOMB (d,p) STRIPPING TO STATES IN ^{117}Sn, ^{123}Sn, AND ^{125}Sn. Carson, Paul Langford. Tucson, Ariz.; Univ. of Arizona (1972). 142p. University Microfilms Order No. 72-11,972.

Thesis.

The nuclear reactions ^{116}Sn(d,p)^{117}Sn, ^{122}Sn(d,p)^{123}Sn, and ^{124}Sn (d,p)^{125}Sn have been studied at incident deuteron energies between 4.35 and 5.55 MeV. Below 5.2-MeV excitation energy, 52 levels are observed in ^{117}Sn, 49 in ^{123}Sn, and 49 in ^{125}Sn. Many of the upper levels in all three nuclei are previously unreported, as is the 0.859-MeV level in ^{125}Sn. Comparison is made between the results and those of other experiments to help establish the orbital angular momentum transfer and total angular momentum of the observed levels. Angular distributions of the differential cross section at several incident deuteron energies have been measured for certain states of interest in ^{117}Sn, ^{123}Sn, and ^{125}Sn. Angular distributions are tabulated for all resolved levels in the ^{116}Sn(d,p)^{117}Sn reaction at 5.35 MeV, and the ^{124}Sn(d,p)^{125}Sn reaction at 5.55 MeV. Cross sections at 160° with E_d = 5.15 MeV are reported for all observed levels in ^{123}Sn. Excitation functions for the ^{116}Sn(d,p)^{117}Sn reaction at deuteron energies between 4.35 and 5.55 MeV in steps of 100 keV were measured at 160° for the first three states in ^{117}Sn. A DWBA stripping analysis of the angular distributions and excitation functions is discussed, and values for the reduced width and spectroscopic factor are given. The spectroscopic factors are relatively insensitive to the optical-model parameters for the deuteron and proton. Values of the spectroscopic factor for a given level at all incident deuteron energies are consistent to better than 10%. The spectroscopic factor, but not the reduced width, is quite sensitive to the method of calculating the neutron bound state wave function. The spectroscopic factors are estimated to be accurate to approximately 15%. Comparison of the present spectroscopic factors with those obtained from other experiments reveals general agreement with most of the other experiments. Occupation parameters from the experimental spectroscopic factors are compared with results from recent pairing theory calculations. It is concluded that pairing theory can describe fairly accurately the filling of shell-model orbits in the ground state of even tin isotopes, and that the lowest levels of the odd tin isotopes can be described as predominantly one-quasi-particle states. (Diss. Abstr. Int., B)

32383 INTERNAL CONVERSION ELECTRON STUDIES IN ^{133}Cs, ^{181}Ta, AND ^{154}Gd. Trueblood, Jon Harold. Columbia, S. C.; Univ. of South Carolina (1971). 130p. University Microfilms Order No. 72-12,030.
Thesis.

Electron internal conversion studies have been conducted in energetic decays of ^{133}Cs, ^{181}Ta and ^{154}Gd. Electron penetration effects have been investigated in the 223 keV and 161 keV transitions of ^{133}Cs. The penetration parameter of the 223 keV transition is evaluated as $\lambda(223) = 2^{+}_{-}$[illegible]. The penetration parameter of the 161 keV transition is evaluated as $\lambda(161) = 34 \pm 7$ on the basis of work undertaken in this investigation and experiments reported in the literature. The K- and LM-shell particle parameters of the 133 keV transition of ^{181}Ta have been measured as $b_2(133K) = 1.79 \pm 0.11$ and $b_2(133LM) = 1.18 \pm 0.10$, respectively, and are to be compared with the theoretical values $b_2(133K) = 1.82$ and $b_2(133LM) = 1.21$. On the basis of the good agreement between theory and experiment in the measurements of the present work and those reported in the literature, the 133 keV transition is interpreted as a normal E2 multipole transition. The K-, L-, and M-shell particle parameters of the 123 keV transition of ^{154}Gd have been measured in two separate series of experiments. From the results of the initial series of experiments, one or all of the particle parameters appeared anomalous. In a subsequent experimental series the measured particle parameters were found to agree closely with first order theory for a normal E2 multipole transition. It is suggested that the conflict between the results of the two series of experiments is due to physical changes in the radioactive europium oxide source used in the experiments. This interpretation could provide a reason for the conflicting experimental values for the particle parameters of the 123 keV transition reported in the literature. (Diss. Abstr. Int., B)

32384 DECAY SCHEME STUDIES OF $^{106\ 108\ 110}$Rh. Takahashi, Kenji. Fayetteville, Ark.; Univ. of Arkansas (1972). 96p. University Microfilms Order No. 72-10,220.
Thesis.

The isomeric states of ^{106,108,110}Rh were studied using a Ge(Li) spectrometer and β- and γ-ray scintillation detectors. Irradiation of enriched ^{110}Pd was found to produce a new radioactivity with a half-life of 34 ± 4 sec which was assigned to ^{110}Rh. A half-life of 5.5 min ^{108}Rh was confirmed by irradiating enriched ^{108}Pd. The decay characteristic of 2.18 h ^{106m}Rh was studied using enriched ^{106}Pd and natural Ag nitrate. Gamma ray intensities, β-ray intensities and coincidence measurements of β-γ and γ-γ were measured along with the half-lives. Ground state and isomeric state spin–parity assignments were deduced in addition to several assignments of spin–parity to the excited levels in the daughter nuclei. The β-decay Q-values for each of the nuclei were also determined. Decay schemes of ^{106,108}Rh and de-excitation transitions of ^{110}Pd are presented and discussed in terms of the more recent theoretical and experimental studies. (Diss. Abstr. Int., B)

32385 CHARGE EXCHANGE REACTION IN INTERMEDIATE WEIGHT NUCLEI. Dunlop, William Henry. Los Angeles; Univ. of California (1971). 107p. University Microfilms Order No. 72-9224.
Thesis.

Angular distributions for the (p,n) reaction populating the isobaric analog state of the ground state of the target nucleus have been measured for ^{91}Zr at 28 MeV incident energy and for ^{119}Sn at beam energies of 28 and 35 MeV. Also the excitation function for the total cross section of the (p,np) reaction has been extended from 20 to 40 MeV for both ^{91}Zr and ^{119}Sn. DWBA calculations were performed to obtain fits to the angular distributions and to the excitation functions using a complex potential for the interaction. The energy dependence of the isospin part of the optical model potential and the ratio of real volume to surface imaginary strengths are determined. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 31061, 31126, 31694, 32035, 32348, 32364, 32368, 32372, 32373, 32383, 32461, and 32605.

32386 (COO–3464-2) DECAY PROPERTIES OF NEUTRON EXCESS ISOTOPES. Technical Progress Report, January 1–December 31, 1971. Preiss, I. L.; Clark, H. M. [Rensselaer Polytechnic Inst., Troy, N. Y.]. Contract AT(11-1)-3464. 14p. Dep. NTIS.

Work is reported on resonance fluorescence studies, isomerism in ^{154}Pb, and two approaches [fast-neutron capture and (α,xp) and (α,np) reactions] to the formation of isomers and new isotopes. Difficulties due to lack of funds are noted. (1 table) (R.W.R.)

32387 (INR-P-1348) ON THE TWO-STEP PROCESS IN DIRECT (d,t) REACTION ON RARE-EARTH NUCLEI. Jaskola, Marian; Kozlowski, Miroslaw (Institute of Nuclear Research, Warsaw (Poland)). 1971. 13p. Dep. NTIS (U. S. Sales Only).

The two-step model of the (d,t) direct reaction on rare-earth nuclei is investigated. The inclusion of the strong coupling in the entrance and exit channels improves the agreement of theoretical angular distributions and experimental data, although a discrepancy in absolute strengths remains. (auth)

32388 BREMSSTRAHLUNG ANGULAR DISTRIBUTIONS AS FUNCTION OF TARGET THICKNESS IN THE ELECTRON ENERGY RANGE 12 TO 22 MeV. Kovalev, V. P.; Kharin, V. P.; Gordeev, V. V. At. Energ. (USSR); 32: No. 1, 77-9(Jan 1972). (In Russian).

The angular distribution of bremsstrahlung was measured in targets of Al, Ti, Cu, Mo, Ta, and W in thicknesses ranging from 0.01 X_0 to 2.2 X_0, where X_0 is the radiation length. For electrons with energies of 12.8, 16.0, and 22.0 MeV, the relative yields of bremsstrahlung are tabulated for angles from 0 to 12°. The largest angular distribution was observed at approximately the thickness corresponding to the maximum bremsstrahlung yield. (2 figures, 1 table) (K.S.W.)

32389 THERMAL-NEUTRON CAPTURE INVESTIGATION OF THE N = 107 ISOTONES OF ^{177}Yb AND ^{179}Hf. Alenius, G.; Arnell, S. E.; Schale, C.; Wallander, E. (Chalmers Univ. of Tech., Goteborg). Nucl. Phys.; A186: No. 1, 209-24 (1972).

The energies and intensities of γ-radiation from thermal-neutron capture in enriched samples of ^{176}Yb and ^{178}Hf have been determined by means of a Ge(Li) pair and anti-Compton spectrometer. Internal reactor targets have been used. The reaction Q-values, the energies of the excited states and their γ-decay have been deduced. The position of the $\frac{1}{2}^-$ [521] hole configuration in ^{177}Yb is discussed. A large number of low K-value states are found both in ^{177}Yb and ^{179}Hf in the range of excitation energy from 1 to 2 MeV. (auth)

32390 COULOMB EXCITATION MOESSBAUER EFFECT IN THE 43.8-keV TRANSITION OF ^{161}Dy. Sylvester, Steven Carl. Chapel Hill, N. C.; Univ. of North Carolina (1971). 77p. University Microfilms Order No. 72-10,775.
Thesis.

The Mössbauer effect of the 43.8-keV state of ^{161}Dy has been observed following Coulomb excitation for several Dy compounds and Dy metal. At liquid nitrogen temperature effects as large as 3.5% were observed. A scintillation counter gave counting rates of up to 5000 cps; 43.8-keV gamma rays made up about 50% of the total count rate. The half-life of this state predicts $2\Gamma_0 = 8$ mm/sec; the most narrow line observed was 16 mm/sec. Dy metal spectra taken at various temperatures were interpreted assuming a normal hyperfine interaction plus a collapsed central peak due to relaxation effects. The extracted value of the magnetic dipole moment for this level of −0.133 ± 0.008 n.m. agrees with the value calculated using the Nilsson model. The extracted value of the ratio of the intrinsic quadrupole moments of the ground and excited states of 1.14 ± 0.54 agrees within experimental error with the value of 1.0 predicted by the Nilsson model. The isomer shift of $DyNi_2$ relative to DyF_3 was found to be −0.29 ± 0.14 mm/sec. The extracted difference in the nuclear radius for the ground and excited states is $\delta R/R = (-1.2 \pm 0.6)(10^{-5})$. A radiation-damage induced isomer shift between DyF_3 and DyF_3 of −0.30 ± 0.10 mm/sec was also observed. (Diss. Abstr. Int., B)

32391 PARTICLE PARAMETER AND INTERNAL CONVERSION COEFFICIENT MEASUREMENTS ON ^{154}Gd. Blanchard, Whitney J. Jr. Baton Rouge, La.; Louisiana State Univ. and

A and M Coll. (1971). 133p. University Microfilms Order No. 72-3462.
Thesis.

The K-, L-, and M-shell particle parameters of the 123 keV transition in ^{154}Gd were carefully measured under five controlled experimental conditions in order to deduce the possible extra-nuclear effects which could alter the conversion electron-gamma and gamma-gamma directional correlations. The data analysis was done with a dual parameter analyzer system which was interfaced to a PDP-8/L computer. The computer was used to set all energy gates, analyze and store data, and compute the anisotropy and uncorrected directional correlation coefficients without further data output. A directional correlation spectrometer, employing special design features for performing both types of correlations without disturbing the source, was used in the measurements. The entire system is capable of rapid data acquisition and analysis. A total of nine directional correlation measurements was performed in a period of two months. The results show that the correlations are sensitive to the preparation, chemical composition, and physical environment of the source and that when careful experimental procedures are employed, the K-, L-, and M-shell particle parameters are found to be normal. The internal conversion coefficients of the prominent transition in ^{154}Gd were measured and compared with theory. The agreement was found to be excellent. Two strong transitions, at 483.9 and 630.3 keV, were observed for which corresponding gamma-rays at 534.9 and 680.6 could not be identified. They were assigned as EO in character. (Diss. Abstr. Int., B)

32392 CORRELATION OF THE PARTIAL RADIATIVE AND NEUTRON WIDTHS IN THE ^{163}Dy(n,γ)^{164}Dy REACTION. Danelyan, L. S.; Demidov, A. M.; Krupin, S. V.; (and others) (Inst. of Atomic Energy, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 2, 425-9(Feb 1972). (In Russian).

The γ ray spectra in the ^{163}Dy(n, γ)^{164}Dy reaction were investigated with a Ge(Li) spectrometer. A number of phenomena of a nonstatistical nature were observed: correlation between the reduced radiative and neutron widths and between various partial radiative widths. The absolute mean reduced partial width was greater than any of those predicted by the various models or based on the experimental data for other nuclei. The degree of freedom of the partial width distribution for transitions to the ground rotational and γ vibrational bands was $\nu = 2 \pm 0.5$. (auth)

32393 STUDY OF THE LEVELS IN ^{183,181}Re, ^{177,175}Ta, AND ^{171,169}Lu WITH THE (α,2nγ) AND (α,4nγ) REACTIONS. Medsker, Larry Robert. Bloomington, Ind.; Indiana Univ. (1971). 136p. University Microfilms Order No. 72-12,965.
Thesis.

The odd-A deformed nuclei, ^{183,181}Re, ^{177,175}Ta, and, ^{171,169}Lu, have been investigated in the (α,2nγ) and (α,4nγ) reactions on ^{181}Ta, ^{175}Lu, and ^{169}Tm targets, respectively. The energies and intensities of the γ-rays have been measured with Ge(Li) detectors in singles and in γ–γ coincidence. The γ-ray time distributions with respect to the cyclotron beam burst and partial angular distributions relative to the beam direction have been obtained. The experimental data have been used to deduce the members of rotational bands in product nuclei, and in some cases the relative positions of band heads have been found. The lifetimes of isomeric states were determined if they were between 5 and ~200 ns. The results for ^{183}Re show two strongly populated rotational bands. The transitions between the members of the $[402\uparrow]$ ground state band are seen up to the ${}^{23}/_{2}{}^{+}$ level. The band is fed at the ${}^{21}/_{2}{}^{+}$ level by the 1907.5 keV isomeric state by means of the 194.8 keV transition. The transitions between the $[514\uparrow]$ band members up to ${}^{19}/_{2}{}^{-}$ are observed, along with the 8 ns delayed transition to the ${}^{7}/_{2}{}^{+}$ member of the ground state band. The E2 transitions between the high-spin members of the $[541\downarrow]$ band have been observed, and the decay from the ${}^{9}/_{2}{}^{-}$ level to the ${}^{7}/_{2}{}^{+}$ level of the ground state band was measured. The transitions among the members of $[402\uparrow]$, $[514\uparrow]$, and $[541\downarrow]$ bands in ^{181}Re have been observed. The $[402\uparrow]$ ground state band is fed at the ${}^{7}/_{2}{}^{+}$ level by means of the 144.6 keV transition from the $[514\uparrow]$ band and the 239 keV transition from the ${}^{9}/_{2}{}^{-}$ member of the $[541\downarrow]$ band. An isomeric state feeds the ${}^{19}/_{2}{}^{-}$ level of the $[514\uparrow]$ band by means of the 328.4 keV transition. The ground state band in ^{177}Ta is built on the $[404\downarrow]$ intrinsic state. The transitions between levels up to ${}^{17}/_{2}{}^{+}$ have been observed. Members up to ${}^{23}/_{2}{}^{-}$ have been seen in the $[514\uparrow]$ band, and a 73.6 keV decay goes from its band head to the ground state. The ${}^{19}/_{2}{}^{-}$ level of this band is strongly fed by the 310.8 keV transition from the 1354.8 keV isomeric state. The high-spin members of the $[541\downarrow]$ band are strongly populated in the (α,2nγ) reaction. In the $[402\uparrow]$ band, transitions between the members up to ${}^{15}/_{2}{}^{+}$ have been measured. The $[514\uparrow]$ and $[541\downarrow]$ bands are strongly populated in the (α,4nγ) reaction leading to ^{175}Ta. The decay of the $[514\uparrow]$ band head to the ground state has been measured with an energy of 131 keV. Evidence for bands built on the $[404\downarrow]$ and $[402\uparrow]$ states has been found. Rotational bands in ^{171}Lu are built on the $[404\downarrow]$ ground state and the $[541\downarrow]$, $[411\downarrow]$, and $[402\uparrow]$ excited states. The 137 keV transition, previously measured, from the ${}^{1}/_{2}{}^{+}$ band head to the ${}^{1}/_{2}{}^{-}$ state in the $[541\downarrow]$ band has been seen, and the lifetime (46 ns) has been measured here for the first time. The members of the $[541\downarrow]$ band up to ${}^{25}/_{2}{}^{-}$ are populated in the (α,2nγ) reaction. Transitions among levels in ^{169}Lu have been observed for the first time. Evidence for members up to ${}^{27}/_{2}{}^{+}$ in the ground state $[404\downarrow]$ band and up to ${}^{33}/_{2}{}^{-}$ in the $[541\downarrow]$ band has been found. The $[411\downarrow]$ and $[402\downarrow]$ bands are weakly populated in the (α,4nγ) reaction. The 161 keV γ-ray has been tentatively assigned as due to the ${}^{1}/_{2}{}^{+} \rightarrow {}^{1}/_{2}{}^{-}$ transition, in analogy with the corresponding transition in ^{171}Lu, and the lifetime has been measured as 31 ns. The results have been combined with information found in the literature to make a comparison of the intrinsic and collective properties of odd-A rhenium (A = 181–187), tantalum (A = 175–183), and lutetium (A = 169–177) nuclei. The systematic trends are discussed in terms of the various theoretical models. (Diss. Abstr. Int., B)

32394 (p,t) REACTION ON RARE EARTH NUCLEI. Goles, Ronald William. East Lansing, Mich.; Michigan State Univ. (1971). 148p. University Microfilms Order No. 72-8658.
Thesis.

The (p,t) reaction on ^{141}Pr, ^{159}Tb, ^{165}Ho and ^{169}Tm has been carried out for the purpose of studying the general systematics of the (p,t) reaction on rare earth nuclei. All experiments were conducted at the bombarding energy of 30 MeV with the exception of the ^{141}Pr(p,t) experiment which was carried out at 40 MeV. The (p,t) reaction on ^{141}Pr was found to strongly populate collective vibrational states in the more or less spherical ^{139}Pr nucleus. Angular distributions of states populated through this reaction were collected between 15° and 65° at 5° intervals and have been compared with distorted wave calculations. In each of the remaining deformed nuclei studied, a strong population of the ground state rotational band was observed with at least six band members being excited in each case. Moreover, a β vibrational band in ^{157}Tb and γ vibrational bands in ^{157}Tb and ^{163}Ho were also found to be strongly excited through this reaction. Angular distributions of states below 1.25 MeV of excitation populated through the ^{159}Tb(p,t) reaction were taken between 10° and 75° at 5° intervals and have been compared with distorted wave predictions. In addition, γ ray experiments involving the ξ/β^{+} decay of ^{167}Yb were conducted in order to complement the ^{169}Tm(p,t) experiment. This decay scheme study has established the existence of twelve new excited states and the probable placement of a thirteenth in the daughter nucleus ^{167}Tm. Moreover, these thirteen states together with the well established low energy level structure of the ^{167}Tm nucleus form a consistent framework for the placement of 52 new γ rays associated with the decay of ^{167}Yb. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, $190 \leq A \leq 219$

Refer also to abstracts 31061, 31702, 32005, 32338, 32348, 32364, 32372–32374, 32412, and 32429.

32395 (FRNC-TH–150) STUDY OF THE ^{197}Au(α,α')^{197}Au REACTION IN AN INCIDENT ENERGY OF 54 MeV. Chevarier, Alain (Lyon Univ. (France)). 1971. 40p. (In French). Dep. NTIS (U. S. Sales Only).
Thesis.

The study of the emission spectrum of α particles in the ^{197}Au (α,α')^{197}Au reaction established the relative importance of the two dominant reaction mechanisms: evaporation of particles from the compound nucleus; emission before equilibrium. At 54 MeV the compound nucleus mechanism is important (75%); α particle emission is in competition with neutron evaporation, the latter process being the more probable with heavy nuclei; thus the compound nucleus mechanism represents only a small part of the total cross section of the (α,α') reaction. In spite of being less favored at this energy pre-equilibrium emission accounts for a large part of the total cross section, charged particles emission being large in comparison with neutron emission. The Griffin model enables much of the observed spectrum to be explained, however significant discrepancies occur at high energies. The choice of n = 3 (number of initial excitons) permits the high energy component to be justified. It thus appears that the α particle retains its individuality during the reaction. (France)

32396 RESONANT BACKSCATTERING OF FAST NEUTRONS. Deconninck, G. (Facultes Univ., Namur, Belg. Centre de Physique Nucleaire, Heverlee, Belg.); Monseu, Ph. Ann. Soc. Sci. Brux. Ser. I; 85: No. 3, 255-63(30 Dec 1971). (In French).

An experimental method has been studied, for the measurement of the fast neutron scattering at angles greater than 175°. An annular scintillator has been used, simultaneously with a light shielding. Measurements on natural lead, between 2.2 and 2.4 MeV show a resonance, in accordance with total cross section measurements. As expected, the backward scattering shows the resonance up. (auth)

32397 STROBOSCOPIC MEASUREMENT OF THE g-FACTORS OF THE 7^- ISOMER IN ^{206}Pb AND THE $^{21}/_{2}{}^{+}$ ISOMER IN ^{207}Bi. Maier, K. H.; Nakai, K.; Leigh, J. R.; Diamond, R. M.; Stephens, F. S. (Univ. of California, Berkeley). Nucl. Phys.; A186: No. 1, 97-109(1972).

The g-factors of the ^{206}Pb 7^- (2200 keV, $T_{1/2}$ = 123μs) and ^{207}Bi $^{21}/_{2}{}^{+}$ (2101.5 keV, $T_{1/2}$ = 182 μs) isomers have been measured by the stroboscopic method using the ^{204}Hg(α,2n)^{206}Pb and ^{204}Hg(^{7}Li, 4n)^{207}Bi reactions to excite them. The results are g(^{206}Pb 7^-) = −0.0217 ± 0.0004 n.m. and g(^{207}Bi $21/2^+$) = +0.325 ± 0.006 n.m. The implications of these values on the wave functions of the states and on the magnetic polarization of the ^{208}Pb core are discussed. (auth)

32398 POPULATION AND DECAY OF THE ISOBARIC ANALOG STATE OF THE ^{208}Pb GROUND STATE IN ^{208}Bi. Woods, Thomas Joseph. Los Angeles; Univ. of California (1971). 117p. University Microfilms Order No. 72-3198.

Thesis.

The isobaric analog state (IAS) of the ^{208}Pb ground state in ^{208}Bi was populated by the (p,A) charge-exchange reaction at proton bombardment energies of 24.8, 30.5, and 38.6 MeV. The IAS thus populated decays by proton channels to the first three states of ^{207}Pb. A somewhat novel technique was developed to obtain angular distributions for this (p,n) reaction utilizing the proton ($\bar{p}$) decay of the IAS. It entails obtaining neutron time-of-flight spectra measured relative to the $\bar{p}$ decay events rather than to the periodic structure of the beam. This technique significantly simplifies experimental arrangements for time-of-flight measurements. The observation of the $\bar{p}$ decay in coincidence with the neutron from the (p,n) reaction allows an accurate determination of the relative widths of the proton decay to the first three states of ^{207}Pb. Comparison of the neutron yields obtained by timing relative to the $\bar{p}$ event and relative to the periodic structure of the beam allows a model independent determination of the ratio of the total proton width to the total state width. Theoretical predictions for the differential cross section of the (p,n) charge-exchange reactions were obtained using Distorted Wave Born Approximation. A form factor with a real volume-shaped part and a surface-peaked imaginary component best represented the measured cross sections. This complex form factor was energy dependent. (Diss. Abstr. Int., B)

32399 MULTIPLET STRUCTURE OF ^{210}Bi FROM THE ^{209}Bi(d, p) AND ^{209}Bi(α, ^{3}He) REACTIONS. Cline, C. K. (Univ. of Rochester, N. Y.); Alford, W. P.; Gove, H. E.; Tickle, R. Nucl. Phys.; A186: No. 2, 273-96(1972).

Levels in ^{210}Bi have been studied by the ^{209}Bi(d, p)^{210}Bi reaction at 19 MeV and the ^{209}Bi(α, ^{3}He)^{210}Bi reaction at 58 MeV. Transfer l-values have been determined and spectroscopic strengths deduced by comparison with measurements of the ^{208}Pd(d, p)^{209}Pb reaction. The observed levels can be interpreted as members of multiplets arising from the weak coupling of an $h_{9/2}$ proton with a neutron in one of the orbits $g_{9/2}$, $i_{11/2}$, $j_{15/2}$, $d_{5/2}$, $s_{1/2}$, $d_{3/2}$ or $g_{7/2}$. The lowest three multiplets are quite pure, while appreciable mixing is found between members of the $\pi h_{9/2}\nu d_{5/2}$ and $\pi h_{9/2}\nu s_{1/2}$ multiplets and between members of the $\pi h_{9/2}\nu g_{7/2}$ and $\pi h_{9/2}\nu d_{3/2}$ configurations. The results show good agreement with recent theoretical calculations of the structure of ^{210}Bi. (auth)

32400 OPTICAL PUMPING DETERMINATION OF NUCLEAR MAGNETIC MOMENTS OF THE MERCURY RADIOISOTOPES 193, 193m, 195m, AND 197m. Moskowitz, Paul A. New York; New York Univ. (1971). 113p. University Microfilms Order No. 72-13,391.

Thesis.

The technique of optical pumping has been used to determine the nuclear magnetic moment of spin-$^3/_2$, 4-h mercury 193, and of the spin-$^{13}/_2$ isomers, 10-h mercury 193m, 40-h mercury 195m, and 24-h mercury 197m. Orientation of the $6s^2$ $^1S_0$ ground state by means of selective excitation of the 6s6p $^3P_1$ excited state, corresponding to the 2537-Å resonance transition, was followed by nuclear magnetic resonance in the ground state. The ratios of the resonance frequencies of the radioisotopes to that of mercury 199, present in the resonance cell for calibration, determined the ratios of the nuclear g-factors. The nuclear magnetic moments were calculated from a previous determination of the nuclear magnetic moment of mercury 199. Differential hyperfine structure anomalies, Δ, have been calculated with respect to mercury 199. The signs of the nuclear magnetic moments were obtained from previous spectroscopic results, and the hyperfine structure anomalies were calculated using previously obtained magnetic dipole hyperfine structure interaction A values for the 6s6p $^3P_1$ level. Nuclear configuration mixing theory has been used to calculate the nuclear magnetic moments and hyperfine structure anomalies for the odd-spin mercury isotopes. Good agreement has been obtained between theory and experiment. (Diss. Abstr. Int., B)

32401 GAMMA RAY SPECTROSCOPIC STUDIES OF STATES IN NEUTRON-DEFICIENT Pb and Tl ISOTOPES. Doebler, Raymond Edwin. East Lansing, Mich.; Michigan State Univ. (1971). 336p. University Microfilms Order No. 72-8675.

Thesis.

In an effort to obtain more information on the energy level systematics in the neutron-deficient lead and thallium isotopes, γ-ray spectroscopic studies have been made on the following isotopes: ^{204m}Pb, ^{203m}Pb, ^{202m}Pb, ^{201}Pb, ^{200}Pb, and ^{199}Pb. A search was also made for an isomeric state in ^{200}Pb. These studies were conducted largely with Ge(Li) detectors in singles, in coincidence and anticoincidence arrangements with NaI(Tl) detectors, and in two-dimensional, Ge(Li)−Ge(Li), multiparameter systems. Using a single-crystal Ge(Li) conversion coefficient spectrometer, K-conversion coefficients for the 899.2-keV E2 and the 911.7-keV E5 transitions in ^{204m}Pb were measured. In the study of the 6.1-s isomer, ^{203m}Pb, a 5.1-keV M2 transition was found to compete with the 825.2-keV M4 isomeric transition. After correcting for this branching decay, the M4 transition probability was found to be consistent with those of the other M4 transitions in the lead region. Six new γ transitions have been assigned to the decay of ^{202m}Pb and a new level has been proposed at 1550-keV in ^{202}Tl, populated by electron-capture from the isomeric state. After an intensive search, an upper limit of ≈1 s was placed on any possible isomeric state in ^{200}Pb. Low-spin states in ^{200}Tl have been studied via the decay of 21.5-h ^{200}Pb. Nineteen γ transitions have been assigned to this decay and all have been placed in a consistent level scheme. States in ^{200}Tl populated in the decay of ^{200}Pb lie at 0, 147.63, 257.19, 289.24, 289.92, 450.56, 525.54, and 605.44 keV. A total of 72 γ transitions have been observed in the decay of 9.4-h ^{201}Pb. Excited states in ^{201}Tl accommodating 65 of these transitions have been placed at 331.15, 692.41, 1098.46, 1134.81, 1157.41, 1238.82, 1277.09, 1290.05, 1330.38, 1401.21, 1420.00, 1445.85, 1479.87, 1550.5, 1617.45, 1639.47, 1672.00, 1712.5, and 1755.31 keV. Eighty-nine of the 117 γ transitions assigned to the decay of 90-min ^{199}Pb have been placed in a decay scheme with levels at 0, 366.90, 720.26, 1120.90, 1241.67, 1482.25, 1502.00, 1528.2, 1554.10, 1632.00, 1658.47, 1695.25, 1725.4, 1749.6, 1768.5, 1891.0, 1898.1, 1930.4, 1959.45, 1977.8, 2031.5, 2159.0, 2206.7, 2226.5, 2237.3, 2367.3, 2433.5, 2547.4, and 2643.2 keV. Unique spin and parity assignments have been made for many of the states observed in these studies, with limits placed on most of the remaining ones. Spin and parity assignments were based on measured conversion coefficients, log ft values, and relative photon intensities. The structures of the states in odd−odd ^{200}Tl are discussed in terms of the coupling of possible single-particle states in adjacent odd-A nuclei. The systematics of the odd-A Tl nuclei, including ^{201}Tl and ^{199}Tl, are discussed in terms of single-particle shell model states coupled to core states of the corresponding Pb nuclei. (Diss. Abstr. Int., B)

32402 ANGULAR DISTRIBUTIONS AND EXCITATION FUNCTION MEASUREMENTS FOR THE CHARGE-EXCHANGE REACTION ^{209}Bi(p,n) ^{209}Po(IAS) AT MEDIUM INCIDENT BOMBARDING ENERGIES AND THE OBSERVATION OF T equals 23 DOUBLE ANALOG STATES IN ^{210}Po. Hoffmann, Gerald Wayne. Los Angeles; Univ. of California (1971). 101p. University Microfilms Order No. 72-9227.

Thesis.

Isobaric analog states in heavy nuclei can proton decay ($\bar{p}$). The $\bar{p}$−n coincidence technique is used to obtain relative angular distributions for the ^{209}Bi(p,n) ^{209}Po(IAS) charge-exchange reaction at 28, 35, and 45 MeV. The same technique is used to measure the $\bar{p}$ isotropy as a function of neutron angle at 28 MeV with neutron angles 20° and 40° and proton angles 90° and 135°, and at 35 MeV with neutron angles 25° and 45° and proton angles 90°, 110°, and 135°. The non-coincidence $\bar{p}$ excitation function is measured from threshold (≃19 MeV) to 45 MeV. The isotropy measurements give further support for the (p,n)-IAS reaction being pure-charge exchange. Theoretical predictions for the differential cross section of the (p,n)-IAS reaction were obtained using the distorted wave Born approximation. The isospin strengths and form factors extracted from the Becchetti–Greenlees optical model parameters give a good representation of the data. The β excitation function results show a broad structure a few MeV above threshold with a gradual decrease in cross section to 45 MeV. DWBA predictions do not reproduce this data. The magnitude is a factor 2 to 5 too low, the structure is not reproduced, and the predicted cross section for the higher energies is rising while the data is falling. Empirical form factors were found which reproduce the excitation function, and these indicate an energy dependence to the isospin potentials. The $T = 23$ states in ^{210}Po ($T_3 = 21$) which are the isobaric analogs of the $T = T_3 = 23$ ground state and low-lying states in ^{210}Pb have been observed as enhancements in the excitation function for the reaction $p + {}^{209}\mathrm{Bi} \rightarrow {}^{208}\mathrm{Pb} + 2p$. The experimentally observed enhancements in the two-proton coincidence excitation function correlate with the known level structure of ^{210}Pb and occur at the incident proton energies predicted by Coulomb energy formulae, thus establishing that these enhancements are due to the population of double analog levels in ^{210}Po. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, $A \geq 220$

Refer also to abstracts 31061, 31072, 32005, 32327, 32343, 32364, 32372, 32374, and 32941.

32403 (AERE-R-6993) DELAYED NEUTRONS FROM FISSION: A COMPILATION AND EVALUATION OF EXPERIMENTAL DATA. Tomlinson, L. (Atomic Energy Research Establishment, Harwell (England)). Feb 1972. 27p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

Experimental data for delayed neutrons from fission (induced by neutrons with energies from thermal to 14.8 MeV) are compiled and evaluated. The following topics are covered: delayed neutron precursors, total number of delayed neutrons per fission; group half-lives and yields; long lived delayed neutron groups; delayed neutron energy groups; delayed neutron energy spectra. (UK)

32404 (COO-3058-15) NEUTRON CAPTURE, FISSION AND TOTAL CROSS SECTION MEASUREMENTS ON ^{240}Pu FROM 20 eV TO 30 keV. Hockenbury, R. W.; Moyer, W. R.; Block, R. C. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Science). [1971]. Contract AT(11-1)-3058. 27p. Dep. NTIS.

The neutron capture and fission cross sections of ^{240}Pu have been measured from 20 eV to 30 keV. Transmission measurements were also made from 30 to 500 eV. The capture data were normalized using the transmission results to minimize the uncertainty in absolute normalization. The average capture cross section has been determined from 6 to 30 keV. The s-wave average radiation width has been found to be (0.0295 ± 0.0015) eV. Resonance parameters to 500 eV and an s-wave strength function of $(1.10 \pm 0.27) \times 10^{-4}$ have also been obtained. Sub-threshold fission structure was observed up to 30 keV. The level spacing for sub-threshold fission was found to be (710 ± 200) eV. Comparisons of all the results are made to previously published data. (auth)

32405 (JINR-P7-6286) PRODUCTION OF SPONTANEOUSLY FISSIONING ISOMERS, WITH NANOSECOND HALF-LIFE, IN THE α-PARTICLE REACTIONS. Gangrskii, Yu. P.; Nguyen Cong Khanh; Pulatov, D. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The targets of thorium, uranium, plutonium and americium were irradiated with α-particles on the isochronous cyclotron of the Laboratory of Nuclear Reactions of the Joint Institute for Nuclear Research. The spontaneously fissioning isomers of plutonium, curium and berkelium with a half-life of 10^{-9} to 10^{-7} sec were produced. The time-of-flight method was used. The obtained data are discussed on the basis of the model of the two-humped fission barrier. (auth)

32406 (ORO-3951-101) EXPERIMENTAL AND THEORETICAL INVESTIGATION OF NUCLEAR FISSION INDUCED BY LOW-ENERGY NUCLEAR PARTICLES. Progress Report. Bacharach, S. L.; Deutsch, R. W. (Catholic Univ. of America, Washington, D. C.). Jan 1972. Contract AT(40-1)-3951. 26p. Dep. NTIS.

Measurements of relative yields, excitation functions, and half-lives of two ^{237}Pu isomers have been completed and published. An attempt to expand the range of isomers which could be studied by developing a nonrecoil technique was abandoned because of background problems. A model for calculating excitation functions for reactions of the form (y,xnf), where y is any incident particle, was developed. The method consists of some refinements to the evaporation model of Jackson and of Vandenbosch, the principal of which is the use of a variable nuclear temperature in the evaporation process. (6 figures) (R.W.R.)

32407 (TRG-Report-2143) FISSION PRODUCT YIELD DATA EXTRAPOLATED FOR SOME ACTINIDES. Sidebotham, E. W. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1972. 12p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

Recommended values of some fission product yields are used to predict the yields for actinides up to ^{242}Cm by the methods of "mirroring" and "mean mass shift." The predictions are in good agreement for those actinides for which the yields were established experimentally. Tables of yields are presented. (auth)

32408 MEASUREMENT OF FISSION-NEUTRON SPECTRA FOR ^{235}U, ^{239}Pu, AND ^{252}Cf. Bluhm, H.; Werle, H. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 17: No. 4, 201-2(Apr 1972). (In German).

Fission-neutron spectra from ^{235}U and ^{239}Pu thermal neutron fission, and spontaneous fission of ^{252}Cf were measured with two different methods using either a proportional counter for recoil protons or a ^{3}H-semiconductor spectrometer. Measurements were conducted on a tangential beam of the reactor FR 2. Above 500 keV, distribution of neutron energies could be described by Maxwell-fits. Between the two measuring methods, mean energies differed by 1% for ^{252}Cf and by 3% for ^{235}U and ^{239}Pu. Data were tabulated and compared with those available in the literature. (H.B.G.)

32409 INTERMEDIATE STRUCTURE IN THE PHOTONEUTRON AND PHOTOFISSION CROSS SECTIONS IN ^{238}U AND ^{232}Th. Mafra, O. Y.; Kuniyoshi, S.; Goldemberg, J. (Instituto de Energia Atomica, Sao Paulo, Brazil). Nucl. Phys.; A186: No. 1, 110-26(1972).

The (γ,f) and (γ,n) cross sections in ^{238}U and ^{232}Th and the ratio Γ_n/Γ_f were measured with monochromatic γ-rays, of energies from 5.43 to 9.0 MeV. The competition between the two processes and the implications of the cross-section behavior are discussed. (auth)

32410 ^{99}Mo FISSION YIELD IN THE THERMAL NEUTRON FISSION OF ^{239}Pu AND ^{235}U. Ramaniah, M. V.; Jain, H. C.; Mathew, K. A.; Avadhany, G. V. N. (Bhabha Atomic Research Centre, Trombay, India). pp 71-8 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148-(Vol.2).

An accurate knowledge of ^{99}Mo fission yield in different fissioning nuclides is essential, since quite often it is used as a standard in fission studies, estimation of fissile materials and sometimes in determination of thermal neutron flux. The large discrepancies in earlier reported values of ^{99}Mo yield in ^{239}Pu fission with thermal neutrons initiated the detailed investigation and its absolute measurement. Absolute measurements have been done using the recent data on decay scheme, facilities available in the determination of absolute disintegration rates, neutron flux measurement in the reactor and irradiating accurately known amounts of ^{239}Pu and and ^{235}U. (auth)

32411 CHEMICAL NUCLEAR DATA: MEASUREMENTS AND APPLICATIONS. Proceedings of the International Conference, Canterbury, England, September 20–22, 1971. Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971). 294p. 6 pounds and 50 pence. (CONF-710950).

Thirty-six papers were presented under the following Session headings: fission yield determination: thermal neutrons; fission yield determination: fast reactor spectra; application of fission yields to burn-up analysis; integral cross sections: light elements; integral cross sections: heavy elements; measurement of decay rates: applications; and data compilation. Discussions are fully reported. Separate abstracts have been prepared for all papers. (UK)

For abstracts of individual papers see: 30720, 30746, 31073–31075, 31134, 31135, 31627, 32305, 32338, 32348, 32372–32374, 32412–32425, 32763, 32770, 32786, 32787, 32793–32795, and 32930.

32412 ASSESSMENT OF FISSION YIELDS. Crouch, E. A. C. (Atomic Energy Research Establishment, Harwell, Eng.). pp 1-6 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

A method has been found of systematically summarizing fission product yields reported in diverse ways. By using this, a computer file library of the literature has been established and forms the basis of an objective method of fission product yield assessment. The assessment is based on expressions derived by application of fission theory, which should describe closely the shape of the curve of fission chain yields versus mass number. The analysis is extended to include independent yields, and the fitting of these analytical expressions to the experimental data should throw some light on the truth or otherwise of the assumptions made in deriving them. (10 references) (auth)

32413 FISSION YIELD MEASUREMENTS IN THE 14 MeV FISSION OF ^{232}Th, ^{233}U, ^{238}U BY DIRECT GAMMA SPECTROMETRY ANALYSIS. Blachot, J.; Cavallini, P.; Chauvin, C. (CEN, Grenoble, France). pp 13-17 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

By using a direct gamma spectrometry analysis with a Ge(Li) detector, cumulative yields of fission products were studied in the 14.7-MeV fission of ^{232}Th, ^{233}U, and ^{238}U. The values obtained for ^{238}U were compared with previous data. (10 references) (auth)

32414 DETERMINATION OF THE ^{148}Nd YIELD IN THE FISSION OF ^{235}U, ^{238}U, AND ^{239}Pu BY THERMAL AND FAST NEUTRONS. Robin, M.; Bouchard, J.; Darrouzet, M.; (and others) (CEN, Fontenay-aux-Roses, France). pp 19-27 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

The yield of ^{148}Nd in the fission of various isotopes was obtained by determination of this element in samples irradiated in thermal and fast neutron spectra. The amount of neodymium thus formed was measured by mass spectrometry, by using the method of double isotopic dilution. For the thermal fission of ^{235}U the yield was determined from the analyses made on natural uranium fuel elements irradiated in a power reactor. In fast spectra, ratios of yields $\gamma^{238}/\gamma^{235}$ and $\gamma^{239}/\gamma^{235}$ were determined with samples of ^{235}U, ^{238}U and ^{239}Pu irradiated in the same assembly. The absolute value for ^{148}Nd yield in the ^{235}U fission was obtained from analyses of RAPSODIE fuel elements. The results are compared with the published values obtained by other laboratories. (12 references) (auth)

32415 FISSION YIELDS IN ACCELERATOR NEUTRON SPECTRA. Cuninghame, J. G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 39-43 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

When fission yields and other nuclear data are required for fission in fast reactor neutron spectra, the serious difficulty arises that such neutron fluxes are very scarce. In the U.K. only the Dounreay Fast Reactor and a low-flux zero assembly at Winfrith produce them uncontaminated by thermal neutrons. However, the situation can be ameliorated by making use of neutrons produced by reactions of photons or protons on heavy elements. In the first case an electron linear accelerator supplies the photons and the photo-neutrons arise from a uranium target. The resulting new neutron spectrum is similar to a "fission spectrum" but can be softened and shaped by suitable techniques making use of absorbers. The second method employs a proton beam from a cyclotron. Bombardment of a heavy metal target produces evaporation neutrons, those at backward angle again having a spectrum resembling a "fission spectrum." Some fast fission yields for ^{239}Pu were measured in the spectra produced in this way, and comparisons are made between the results for two different spectra. A measurement was also made of the (n,p) cross-section of ^{35}Cl in one of the spectra. (0 references) (auth)

32416 MEASUREMENT OF FISSION YIELDS IN THE DOUNREAY FAST REACTOR. Sinclair, V. M.; Davies, W. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). pp 45-50 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

Two series of fission yield measurements were made in the Dounreay Fast Reactor. The first was based on the mass spectrometric measurement of the consumption of fissile materials; the yields of ^{90}Sr, ^{137}Cs, ^{144}Ce and ^{143,145,146,148,150}Nd were determined for both ^{235}U and ^{239}Pu. The second series was carried out at low power and the consumption of fissile material was based on fission chamber measurements; the yields of ^{89,90}Sr, ^{95,97}Zr, ^{99}Mo, ^{111}Ag, ^{140}Ba, and ^{141,144}Ce were determined for ^{235}U. Radiochemical methods were employed for the determination of the radioactive fission products, and isotope-dilution mass spectrometry for the determination of the stable Nd fission products. The accuracy and precision of the final results and the intermediate data are considered. The fission yields obtained were compared with fast fission yields reported by other workers. Future work on fission yields in the Dounreay Fast Reactor and the Prototype Fast Reactor is briefly discussed. (3 references) (auth)

32417 FRACTIONAL INDEPENDENT YIELDS OF SOME IODINE AND XENON ISOTOPES IN FAST NEUTRON INDUCED FISSION OF ^{232}Th. Qaim, S. M.; Denschlag, H. O. (Univ., Mainz). pp 51-7 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

By means of radiochemical isolation of fission iodine by exchange on a preformed AgCl precipitate, in less than 3 sec after a short irradiation, the fractional independent yields of ^{133}I, ^{134}I and ^{135}I in the fast reactor-neutron and 14 MeV-neutron-induced fission of ^{232}Th were measured. The fractional independent yield of ^{135}Xe in 14 MeV-neutron-induced fission was estimated by measuring the growth and decay of this nuclide in the irradiated ^{232}Th. The yields were used for studying charge distribution in medium-energy fission. The width parameter (σ) of the Gaussian charge dispersion curve for chain 135 in the 14 MeV-neutron-induced fission was obtained experimentally. The dependence of charge dispersion on the fissioning nucleus, fragment mass and excitation energy of the compound nucleus was investigated. The results are discussed in terms of the effect of increasing incident neutron energy on charge distribution. (13 references) (auth)

32418 DETERMINATION OF THE CAPTURE TO FISSION RATIO AND THE FISSION PRODUCT YIELDS OF FISSILE MATERIALS IRRADIATED IN THE DOUNREAY FAST REACTOR. Crouch, E. A. C. (Atomic Energy Research Establishment, Harwell, Eng.). pp 147-53 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

It is in principle an easy matter to determine the capture-to-fission ratio (α) for neutron-irradiated fissile materials. However, in actual irradiations the direct products of fission and capture may be themselves subject to neutron capture, and irradiation conditions are in practice never steady. Expressions for α are derived depending on those parameters which can, in fact, be measured in irradiated fuels, some experimental results for DFR are quoted, and some of the difficulties are discussed. (6 references) (auth)

32419 MEASUREMENT OF INTEGRAL CROSS SECTIONS OF HEAVY ISOTOPES BY IRRADIATION IN FAST NEUTRON SPECTRA. Bouchard, J.; Barre, J.-Y.; Boyer, R.; Darrouzet, M.; Frejaville, J. pp 155-60 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

Irradiations of small uranium and plutonium samples in RAPSODIE and in a softer spectrum (inside a boron capsule put in the swimming pool reactor OSIRIS), followed by mass spectrometry measurements, have given capture cross section ratios for ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu and ^{241}Pu with a very good accuracy. With physical measurements of fission ratios and two methods of capture-to-fission calibration, α values were obtained for these isotopes. (7 references) (auth)

32420 CAPTURE AND ABSORPTION CROSS SECTIONS OF ^{232}U FOR THERMAL NEUTRONS. Cabell, M. J.; Wilkins, M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 161-7 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

Aliquots of a mixture prepared from isotopically pure (98.9%) ^{232}U and isotopically enriched (99.76%) ^{236}U were irradiated, with cobalt monitors, in the DIDO reactor for two years. The irradiation positions chosen provided essentially thermal neutrons ($r\sqrt{T/T_0} = (8.6 \pm 1.2) \times 10^{-4}$) of known temperature (116 ± 9°C). After irradiation the uranium was purified by reversed-phase partition chromatography, then mass analyzed. Unirradiated samples of the mixture were mass analyzed in a similar way. The activities of the cobalt monitors were determined absolutely, and the neutron doses (i.e., $(nv_0)t$) they received were calculated with an absolute accuracy of ±1.2%. The calculations took into account the detailed history of the irradiation. The thermal-neutron absorption and capture cross sections of ^{232}U were found to be 148.3 ± 4.4 b and 73.1 ± 1.5 b, respectively; $\hat{\alpha}$ was found to be 0.972 ± 0.061. These results are more precise than, but in substantial agreement with, earlier measurements of the total, capture and fission cross sections of this nuclide. (19 references) (auth)

32421 SUPERHEAVY ELEMENTS. Newton, G. W. A. (Univ. of Manchester, Eng.). pp 171-4 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

The possibility that long-lived elements may exist in an island of stability around Z = 114 and N = 184 (or 196) has captured the imagination of nuclear scientists. There have been several attempts to make or find these elements, but so far without definite success. These attempts are surveyed and some of the difficulties encountered in the British experiments are outlined. (32 references) (auth)

32422 ALPHA HALF-LIFE OF ^{234}U. Lounsbury, M.; Durham, R. W. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 215-19 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

Electrosprayed sources of ^{234}U were prepared at the Bureau Central de Mesures Nucleaires, Euratom, from NBS Uranium Isotopic Standard U-930. For each source, the disintegration rate was determined by low-geometry alpha counting, and the number of ^{234}U atoms, by mass spectrometric isotope dilution analysis, by using ^{233}U as the spike. A value of (2.444 ± 0.012) × 10^5 years was obtained for the alpha half-life of ^{234}U. (20 references) (auth)

32423 HALF-LIFE OF ^{234}U. de Bievre, P.; Lauer, K. F.; le Duigou, Y.; (and others) (Central Bureau for Nuclear Measurements, Geel, Belgium). pp 221-5 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

By using several different methods and materials the half-life of ^{234}U was determined to be 2.446 × 10^5 y + 0.3%. (51 references) (auth)

32424 FISSION DELAYED NEUTRONS: A REVIEW. Tomlinson, L. (Atomic Energy Research Establishment, Harwell, Eng.). pp 239-45 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

Recent experimental and theoretical studies of fission product delayed neutrons are briefly reviewed; areas in which delayed neutrons are of technological importance are discussed. (30 references) (auth)

32425 DATA COMPILATION FOR CALCULATING FISSION HEAT AND RADIATION. Sidebotham, E. W. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 281-5 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

A brief description of the method of researching the data is given. Methods of checking and rectifying data using computer programs and integral data are outlined. Particular attention is given to fission products and their energy releases. (23 references) (auth)

32426 FISSION MODES OF THE ^{242}Am FISSION ISOMER. Griffith, Gary Len. Manhattan, Kan.; Kansas State Univ. (1971). 110p. University Microfilms Order No. 72-9763.

Thesis.

The fission modes of ^{242m}Am isomeric fission have been measured using the ^{242}Pu(d,2n)^{242m}Am reaction with 22.7-MeV deuterons. The fission isomer distributions in mass and kinetic energy were determined by coincident measurement of the two fragment energies. A total of 1201 fission fragment pairs were recorded. The mass and kinetic energy distributions were compared to similar energy-energy data obtained by Fontenla for ^{241}Am + n prompt fission. The centroid locations for ^{242}Am isomeric fission distributions were measured to be $138.9^{+.7}_{-.5}$ amu and $103.1^{+.8}_{-.7}$ amu for the mass peaks, $76.6^{+1.3}_{-1.7}$ MeV and $102.8^{+1.2}_{-1.1}$ MeV for the single-fragment kinetic energy peaks, and $179.4^{+3.1}_{-2.1}$ MeV for the total kinetic energy distribution. The full width at half maximum of the total kinetic energy distribution was measured to be $24.9^{+2.1}_{-1.0}$ MeV. The full width at half maximum of the heavy mass peak of the mass distribution was measured to be $14.2^{+2.8}_{-1.0}$ amu. The peak-to-valley ratio (where the valley yield was determined by averaging the yield at masses 121 amu, 122 amu, and 123 amu) was measured to be 49^{+27}_{-18}. Except for the mass peak centroids and the single-fragment kinetic energy peak centroids, these values are the same within the statistical and experimental uncertainties as the values for thermal-neutron induced fission of ^{241}Am. (The centroids of the singles kinetic energy peaks have not been determined for ^{241}Am + n.) The differences in the measured mass centroid locations might not be significant because of the expected mass centroid uncertainties in the ^{241}Am + n fission experiment. These energy-energy measurements indicate that several properties of the ^{242}Am isomeric fission distributions are in agreement with prompt fission systematics. The mass asymmetry, location of the heavy mass peaks, and the total kinetic energy agree with the systematics of prompt fission. The effects of neutron emission and experimental dispersions have been estimated for the energy-energy data of both ^{242}Am prompt and isomeric fission. These effects were estimated by a transformation of radiochemical data for ^{241}Am + n to make the radiochemical data directly comparable with energy-energy data. The effects of differing amounts of experimental dispersions were also estimated. (Diss. Abstr. Int., B)

Nuclear Theory

Refer also to abstracts 31823, 32128, 32198, and 32263.

32427 (AAEC/TM-607) METHOD FOR INVERTING THE CHANNEL MATRIX IN NUCLEAR RESONANCE THEORY. Bertram, W. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nov 1971. 9p. Dep. NTIS (U. S. Sales Only).

A technique is presented for inverting the channel matrix which occurs in R-matrix theory. The collision matrix can be expressed in a form which does not involve matrix inversions; it can be evaluated by the application of a recurrence relation. The connection between this method and the level matrix formalism is examined. (auth) (Australia)

32428 (COO-3001-4) NEW TREATMENT FOR THE PROJECTION OPERATOR IN NUCLEAR G-MATRIX EQUATION. Tsai, S. F.; Kuo, T. T. S. (State Univ. of New York, Stony Brook. Dept. of Physics). [nd]. Contract AT(11-1)-3001. 19p. Dep. NTIS.

A new solution for the nuclear G-matrix is derived. In this solution, the projection-operator dependent part of the G-matrix is separated out as an additive term and can be evaluated conveniently without solving any coupled integral equations. The combination of this solution with the momentum-space matrix inversion method provides a very simple and promising method for the calculation of the nuclear G-matrix. (auth)

32429 (COO-3463-1) COMPOUND NUCLEUS AND ITS DECAY. Sperber, Daniel (Rensselaer Polytechnic Inst., Troy, N. Y.). [1971]. 78p. Dep. NTIS.

The theory of the statistical compound nucleus is developed and applied to experimental reaction data. Emphasis is on the highly excited states in the continuum of strongly overlapping levels. After a brief history of the compound-nucleus model, an updated version for the nucleon and gamma decay rates is derived. The treatment of excitation functions in which more than one particle can be emitted is considered, and the theory is applied to the evaluation of the cross section for (α,xn) reactions. A method for the calculation of angular distributions is derived and compared with experiment. A rigorous statistical theory for capture reactions is developed and evaluated. Finally, the method is applied to the analysis and interpretation of isomer ratios for shape or spin isomers. It is shown that the compound-nucleus statistical model can explain a large amount of data while satisfying the hypothesis of independence of formation. Information about nuclear level density and the parameters on which this depends is extracted. (9 figures, 6 tables, 148 references) (R.W.R.)

32430 (COO-3463-6) NEUTRON AND GAMMA EMISSION FROM HIGHLY EXCITED STATES AND STATES WITH HIGH

SPIN. Annual Progress Report. Sperber, Daniel (Rensselaer Polytechnic Inst., Troy, N. Y.). Mar 1972. Contract AT(11-1)-3463. 6p. Dep. NTIS.

Problems related to statistical theory of nuclear reactions were investigated. Attention was focused on the following aspects: unified model for the statistical decay of the compound nucleus; studies of excitation functions and isomer ratios for spin isomers in heavy-ion reactions; statistical theory of shape isomers; and synthesis of superheavy elements in (HI,xn) reactions. Details of this work can be found in the open literature and in reports COO-3463-1, -2, and -3. (R.W.R.)

32431 (IAE-2013) PHASE TRANSITIONS IN NUCLEI. Nosov, V. G. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 50p. Dep. NTIS (U. S. Sales Only).

Depending on the number of nucleons, a jumplike change of the equilibrium shape of the nucleus is considered as a phase transition. Experimental data justify taking, as a phenomenological parameter of the theory describing one of the phases, not the deformation of the nucleus but another quantity characterizing the extent of closeness of the inner structure of the nucleus to the magic. Then the deformation, along with the number of particles, proves to be that free parameter the change of which leads to the continuous phase transition under consideration. The sign of the rigidity jump of the spherical nucleus at the Curie point is determined, and the limiting expression is found for the mass coefficient of one of the phases. The nature of instability of the spherical configuration of the nucleus originating in this phase is illustrated using a simple model. (auth)

32432 (JINR-P4-6258) PAIR ROTATIONS AND THE PROBLEM OF "SPURIOUS" STATE EXCLUSION. Dzholos, R. V.; Rybarska, V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

The errors are analyzed characteristic of different approaches to the problem of the "spurious" state separation in the case of pair correlations. It is shown that the Belyaev–Zelevinskii method allows an exact solution of the problem to be obtained. (auth)

32433 (JINR-P4-6279) DERIVATION OF EQUATIONS OF THE ODD-MASS NUCLEUS ROTOR MODEL FROM THE MANY-PARTICLE SCHROEDINGER EQUATION. Aleksandrov, L.; Karadzhov, D.; Mikhailov, I. N.; Nadzhakov, E.; Khodzhaev, G. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1972. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

A generalized system of equations of the odd-mass deformed nucleus rotor model is obtained by the projection method. In deriving the equation, the approximation about the separability of the total spin into commuting parts, which correspond to the core and odd nucleon, was not used. The nonadiabatic character of the core rotation was taken into account in the equations. (auth)

32434 (JINR-P4-6293) CORRELATIONS BETWEEN REDUCED PARTIAL ALPHA WIDTHS AND NEUTRON AND RADIATIVE WIDTHS IN NEUTRON RESONANCES. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 9p. (In Russian). Dep. NTIS (U. S. Sales Only).

The cases are considered in which there may exist correlations between reduced partial alpha widths $\Gamma^0_{\alpha\lambda f}$ and reduced neutron widths $\Gamma^0_{n\lambda}$ and also between $\Gamma^0_{\alpha\lambda f}$ and partial radial widths $\Gamma^0_{n\lambda}$ in neutron resonances. It is shown that there may occur large correlations between $\Gamma^0_{n\lambda}$ for s-wave neutron capture by an even–even spherical nucleus and alpha transition to the $j^\pi = 1/2^+$ state. Significant correlations between the alpha and gamma widths may be expected in the cases when alpha and E1 transitions proceed to the ground states of even–even nuclei as well as in the cases when alpha transition goes to the ground state and E1 transitions go to the one-phonon and two-phonon states. (auth)

32435 (JINR-P4-6310) ANALYSIS OF THE ELASTIC SCATTERING OF ELECTRONS BY LIGHT NUCLEI ON THE BASIS OF THE SYMMETRIZED FERMI DENSITY. Eldyshev, Yu. N.; Luk'yanov, V. K.; Pol, Yu. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

Using the analytical expressions for the charge form factors obtained with the symmetrized Fermi density it is possible to explain the experimental data for momenta transfer less than 7.7 $A^{-1/3}$ Fermi^{-1} where the role of the surface nucleus is the most effective. At large momenta transfer the details of the interior nuclear structure play the determining role. (auth)

32436 (JINR-P7-6291) COMPOUND NUCLEUS LIFE-TIME MEASUREMENTS USING THE BLOCKING EFFECT. Kamanin, V. V.; Karamyan, S. A.; Kucher, A. M.; Normuratov, F.; Oganesyan, Yu. Ts. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The influence of the experimental conditions on compound nucleus lifetime measurements using the blocking effect has been studied. Stability of the obtained data with respect to worsening of monocrystal quality and to thickness increase of the operating layer of the target has been shown. Weak energy dependence of the blocking effect intensity has been proved experimentally. The performed experiments speak in favor of correctness of the previously obtained lifetimes of compound nuclei produced in the interaction of W nuclei with accelerated heavy ions. (auth)

32437 (LA-tr-72-4) EXPANSION OF THE SIEGERT THEOREM FOR β TRANSITIONS. Eichler, Joerg. Translated by Alois David Cernicek (Los Alamos Scientific Lab., N. Mex.), from Z. Phys.; 171: 463-75(1963). 19p. Dep. NTIS.

Assuming the validity of the conserved vector current hypothesis, the well-known Siegert theorem for electromagnetic transitions is extended to vector transitions in beta decay. The starting point is an appropriate definition of the current density by means of the nuclear Lagrangian. The current has three components in isospace. The third component (which is responsible for electromagnetic transitions) is conserved strictly but the other two (which are responsible for beta decay) have a finite divergence caused by electromagnetic interactions. The explicit form of the divergence in terms of the Lagrangian leads to an estimate which apart from small corrections is independent of nuclear structure. Now this expression is used to obtain approximate relations between matrix elements containing the current density and matrix elements containing charge distributions only. After elimination of the former matrix elements the number of free parameters entering into the analysis of beta decay experiments is reduced. Experiments seem to indicate the validity of the predicted relations between matrix elements. (auth)

32438 (N-72-12687) NUCLEAR ELECTROMAGNETIC CASCADES FROM NUCLEI WITH Z LARGER THAN OR EQUAL TO 3. Jones, W. V. (Louisiana State Univ., Baton Rouge. Dept. of Physics and Astronomy. Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). [1971]. Contract NAS9-10986. 6p. (NASA-CR-124581; OG-57. NTIS.

A Monte Carlo simulation method was developed for studying nuclear-electromagnetic cascades initiated by high energy nuclei with Z > or = 3 incident on heavy absorbers. The calculations are based on a cascade model which was first adjusted until it agreed with measurements made with protons at an accelerator. Modifications of the model used for protons include the incorporation of the probabilities for fragmentation of heavy nuclei into lighter nuclei, alpha particles, and nucleons. Mean values and fluctuations of the equivalent numbers of particles in the cascades at various depths in an iron absorber are presented for protons, carbon, and iron nuclei over the 30 to 300 GeV/nucleon energy range. (auth) (STAR)

32439 (NP-19234) NUCLEAR CORE RENORMALIZATION. I. COULOMB ENERGY DIFFERENCES. Note No. 344. Camiz, P.; D'Andrea, A.; Olivieri, E.; Scalia, M. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 18 Nov 1971. 17p. Dep. NTIS (U. S. Sales Only).

Core-renormalization in light nuclei is introduced through a dependence of the core radius on the occupation number of the last shell, in a linear approximation. The corresponding coefficient for the shells $1p^{3/2}$, $1p^{1/2}$, $1d^{5/2}$, $2s^{1/2}$, $1d^{3/2}$, $1f^{7/2}$, is obtained by fitting experimental Coulomb energy differences with a modified Hecht's mass formula, containing four adjustable parameters. Evidence is found for a renormalization effect corresponding to a dilatation of the core. (auth)

32440 (RLO-1388-629) NUCLEAR ROTATION IN HEAVY ION SCATTERING. Mosel, U. (Washington Univ., Seattle. Dept. of Physics). [nd]. 6p. Dep. NTIS.

The effects of the finite size of the scattering partners are taken into account in a description of heavy-ion interactions. The conclusions are similar to those of recent work on the same subject by Seglie and Inglis. It is shown, however, that these authors are using an incorrectly quantized Hamiltonian. (auth)

32441 MASS PARAMETER OF FISSION ASYMMETRY. Kurochkin, S. G.; Cherdantsev, P. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 3, 157-9(1971). (In Russian).

An analytical form of the effective nuclear mass as a function of the deformation β and the width of the neck 2C was obtained. A Laplace equation in toroidal coordinates which described a nuclear liquid with a given velocity potential was solved. After suitable mathematical treatment five values of the parameter C were assumed, and five curves which represented mass parameters of fission asymmetry were constructed. (2 figures) (K.S.W.)

32442 SO(5) WIGNER COEFFICIENTS FOR THE 14-DIMENSIONAL REPRESENTATION. Wong, M. K. F. (Fairfield Univ., Conn.). Nucl. Phys.; A186: No. 1, 177-99(1972).

SO(5) Wigner coefficients in the direct product of the 14-dimensional representation with an arbitrary representation have been obtained. These coefficients are applicable to the theory of quasi-spin in nuclear physics. In general there is a multiplicity problem of two involved in the direct product $(a,b) \otimes (1,1) \rightarrow 2(a,b)$. The problem is solved by constructing two tensor operators formed out of the generators that transform like the (1,1) representation. The method can be used to solve the multiplicity problems of other Wigner coefficients. (auth)

32443 FISSION PROPERTIES OF HEAVY AND SUPER-HEAVY NUCLEI. Schmitt, H. W. (Oak Ridge National Lab., Tenn.); Mosel, U. Nucl. Phys.; A186: No. 1, 1-14(1972).

Calculations have been carried out to estimate the total fragment kinetic energies E_K, total fragment excitation energies E_X, and approximate total number of neutrons ν emitted in the binary fission of heavy and superheavy nuclei. The kinetic energy calculations are based on a static scission model reported earlier for fissioning nuclei in the actinide region. The total energy release Q is calculated from a recent mass formula of Seeger, and the total excitation energy is obtained from the difference, $E_X = Q - E_K$. The results show a strong peak in $E_K(A)$ [A = compound nucleus mass number] and a corresponding minimum in $E_X(A)$, at $A \approx 264$, corresponding to fission into two nearly double-magic ($Z \approx 50$, $N \approx 82$) fragments. The predictions of E_K, E_X, and ν disagree sharply with the liquid-drop predictions in the range $255 \lessapprox A \lessapprox 290$. It appears from these results that kinetic energy measurements do not provide an unambiguous test for superheavy nuclei, while measurements of ν, if $\nu \gtrapprox 5$, seem to provide such a test. (auth)

32444 SHELL-MODEL THEORY OF COMPLEX COLLISIONS. Yukawa, T. (Rutgers–The State Univ., New Brunswick, N. J.). Nucl. Phys.; A186: No. 1, 127-44(1972).

A microscopic theory of heavy-ion reactions is proposed based on the assumption that the set of antisymmetrized products of shell-model wave functions spans the complete Hilbert space of the system. The many-body Schrödinger equation and the equations given by the scattering theory of Ekstein are represented by the basis set, fully taking the Pauli principle into account. A set of coupled equations, which resembles that of the generator coordinate method, is obtained and reduced to a set of coupled integro-differential equations which leads to a simple physical picture for the scattering process of complex particles. The interactions between composite particles which have direct relations to the T-matrices for elastic, inelastic and rearrangement collisions are expressed in terms of shell-model $^{16}O + ^{16}O$ wave functions and the nucleon-nucleon interaction. A simple example is given for the local potential to lowest order. (auth)

32445 HARTREE-FOCK NUCLEAR CALCULATIONS WITH GAUSSIAN POTENTIALS. Allard, J. F.; Abzouzi, A.; Houssais, B. (Institut d'Etudes Nucleaires, Algiers). Comput. Phys. Commun.; 3: No. 1, 22-30(Jan-Feb 1972).

The HARFOCK program calculates a self-consistent nuclear field and determines orbital energies and wavefunctions using Gaussian potentials. HARFOCK is in FORTRAN IV for the IBM 360/40. (J.W.R.)

32446 GENERALIZED TRANSFORMATION BRACKETS FOR THE HARMONIC OSCILLATOR FUNCTIONS. Sotona, M.; Gmitro, M. (Nuclear Research Inst., Rez, Czech.). Comput. Phys. Commun.; 3: No. 1, 53-60(Jan-Feb 1972).

The OSCILLATOR BRACKETS program calculates transformation coefficients for the expansion of coupled harmonic oscillator wave functions into coupled pairs of relative and center-of-mass functions. The program is in FORTRAN IV for the IBM 7040. (J.W.R.)

32447 FORTRAN PROGRAM FOR THE COMPUTATION OF THE GENERALIZED TALMI COEFFICIENTS. Zohni, O. (International Centre for Theoretical Physics, Trieste, Italy). Comput. Phys. Commun.; 3: No. 1, 61-8(Jan-Feb 1972).

The TALMI program calculates Talmi coefficients for obtaining the center-of-mass and relative wavefunctions for two particles of different masses moving in a harmonic oscillator potential. These coefficients are useful in separating the c.m. motion of a group of nucleons in the shell model and of nucleon clusters in the cluster model. The program is in FORTRAN for the IBM 7044. (J.W.R.)

32448 WIGNER SUPERMULTIPLET BASES AND COUPLING COEFFICIENTS. Ahmed, Khursheed. Montreal; McGill Univ. (1971). National Library of Canada, Ottawa.
Thesis.

Two sets of bases for the Wigner Supermultiplet Scheme are constructed—the non-canonical chain $SU(4) \supset SU(2) \times SU(2)$. The first ones are analogous to the $SU(3) \supset 0(3)$ basis states of Bargmann and Moshinsky; they are defined by identifying them with products of powers of certain elementary multiplets. The second are the analogs of the $SU(3) \supset 0(3)$ states of Elliott; they are obtained by projecting good $SU(2) \times SU(2)$ states out of certain simple intrinsic states. Clebsch–Gordan and Wigner coefficients are derived for coupling of states for certain classes of representations. (Diss. Abstr. Int., B)

32449 PION-EXCHANGE CONTRIBUTIONS TO THE PARITY-VIOLATING INTERNUCLEON POTENTIAL. Schuelke, L. (Ruhr-Univ., Bochum, Ger.). Nucl. Phys.; B40: 386-96(1972).

Arguments are given that the factorization approximation should give the right order of magnitude if applied to the strangeness non-changing weak meson-nucleon vertex. This means that the currently used strength of the ρ-exchange potential V_ρ is approximately correct, while the one-pion exchange contribution V_π has likely been overestimated. In our model, which treats both the weak ρ- and π-coupling on the same footing, V_π becomes proportional to the neutron-proton mass difference and is therefore zero if no isospin-breaking is taken into account. It is further shown that (2π)-contributions are likewise zero even in case that one of the internal nucleon lines is a higher nucleon resonance, and that in lowest order the weak γ-emission becomes zero too. (auth)

32450 NUCLEAR REACTION ANALYSIS USING A COMBINED POTENTIAL AND R-MATRIX FORMALISM. Westin, Glenn David. Athens, Ohio; Ohio Univ. (1971). 228p. University Microfilms Order No. 72-9599.
Thesis.

The combination of a potential model within the framework of the Wigner–Eisenbud R-matrix theory, and the application of this formalism to several single-channel scattering examples and one two-channel situation. The procedure used involved first determining potential model parameters which fit the gross features of the (elastic) scattering cross section. The logarithmic derivative and reduced width of the resonant partial wave were then evaluated as functions of energy for several radii. The background term R^0 was determined as a function of both energy and radius using this information. The value of the logarithmic derivative used in the R-matrix parametrization was calculated from the (potential) partial wave of the same J^π value as the resonance under study. The energy at which this parameter was evaluated was generally chosen as the single-particle energy nearest the resonance being parametrized. Using the values of the logarithmic derivative, radius, and background determined as indicated above, resonances were then parametrized in the usual fashion. The examples studied included the $5/2^+$ and $3/2^+$ resonances at 2.08 and 3 MeV in $^{12}C(n,n)^{12}C$ and the $3/2^+$ and $1/2^+$ structures in $^{16}O(n,n)^{16}O$ at 1 and 2.4 MeV respectively. The $3/2^+$ resonance at 8.08 MeV in ^{17}O was also studied using a two-channel R-matrix formalism. A two-level expression was developed using inhomogeneous R-matrix theory. The formula was applied to two cases of interfering levels: the two $3/2^+$ resonances in $^{12}C + n$ at about 3 MeV; and the bound $2s_{1/2}$ and scattering $s_{1/2}$ state at 2.4 MeV in $^{16}O(n,n)^{16}O$. The method was extended to include complex boundary conditions and reduced widths, and applied to scattering from complex square and Saxon–Woods wells. Spectroscopic factors were calculated for the $5/2^+$ state in $^{12}C(n,n)^{12}C$ at 2.08 MeV as a function of radius, and for the $3/2^+$ double resonance in $^{12}C(n,n)^{12}C$ as a function of energy. An attempt was also made to compute a spectroscopic factor for the s-wave dip at 2.4 MeV in $^{16}O(n,n)^{16}O$. The potential-resonance method proposed seems capable of yielding good fits to the data without extensive searching for the proper value of R^0. Also, this method of calculating the boundary condition for the R-matrix states allows the use of R-matrix energies close to those observed in the cross section. In the two-channel case, values of R^0 considerably different from their predicted values caused severe effects not only in the elastic channels, but in the reaction channels as well. The outcome of the inhomogeneous R-matrix is that the choice of identical boundary conditions for two interfering states produces the best fit to the data. The spectroscopic factor does not appear to be a meaningful quantity in the continuum for those states which are broad. Also, the spectroscopic factor seems to show a slight radius dependence when the narrow

$^{5}/_{2}{}^{+}$ resonance at 2.08 MeV in ^{12}C + n is examined from 5 to 30 fm. No value for the spectroscopic factor is determinable for the s-wave dip in ^{16}O(n,n)^{16}O. (Diss. Abstr. Int., B)

32451 PAULI BREAK-UP IN DEUTERON REACTIONS. Gambhir, Brij Lal. College Park, Md.; Univ. of Maryland (1971). 152p. University Microfilms Order No. 72-12,753.
Thesis.

The binding energy of a model deuteron propagating in the presence of a nuclear fermi gas is calculated as a function of the nuclear density and deuteron kinetic energy. The results show that the neutron–proton system is unbound in the presence of nuclear matter unless it has a kinetic energy at least of the order of 100 MeV. This change in binding energy arises from the phase space restrictions imposed by the Pauli exclusion principle. To investigate the importance of the Pauli mechanism in nuclear reactions, a theoretical study of the deuteron breakup reaction was performed. Although the deuteron break-up reaction is a 3-body problem with usual divergence difficulties, a Hilbert–Schmidt integral equation for the break-up amplitude was obtained from which the Pauli term can be singled out. The corresponding Pauli break-up cross-sections for deuterons on ^{16}O nucleus have been calculated in a simple model. Important features of energy and angular correlations are discussed. The variation of cross-sections with incident energy and nuclear density is also studied. The magnitudes of the Pauli break-up cross-sections (e.g., a peak value of 100 mb/^{2}Sr MeV at forward angles and for an incident energy of 91 MeV) guarantee that for forward angles and intermediate energies, an accurate and complete description of reactions involving deuterons must not omit the Pauli mechanism. Finally, for the deuteron elastic scattering and stripping reactions also, Hilbert–Schmidt integral equations were obtained in which the Pauli term can be isolated. From considerations of an artificially tightly bound deuteron, some qualitative inferences regarding the importance of the Pauli mechanism in α-particle reactions are also drawn. (Diss. Abstr. Int., B)

32452 THEORETICAL STUDIES IN THE THREE-NUCLEON SYSTEM. Lavine, James Philip. College Park, Md.; Univ. of Maryland (1971). 148p. University Microfilms Order No. 72-12,738.
Thesis.

An angular momentum decomposition is presented for the Faddeev–Lovelace formulation of the three-body problem. The result is a coupled system of integral equations with two continuous variables. Several aspects of the three-nucleon problem are investigated with this formalism. The first concern is with theoretical approaches to neutron–deuteron break-up calculations with local potentials. Two new approaches to break-up calculations are presented. One involves complex momenta and contour distortions to avoid the singularities due to the bound-state poles of the two-body scattering amplitudes and to the poles of the free three-particle Green's function. The second approach uses only real momenta and takes advantage of the independence of the integration limits from the variables of integration in the version of the Faddeev–Lovelace equations used here. Both of these approaches to break-up require large-scale numerical calculations and before they are undertaken, much numerical experience is needed with simpler three-nucleon problems. Results are presented for two investigations that are motivated by this need to understand the details of the three-nucleon problem. The first investigation is a study of three-nucleon properties with separable potentials to determine the critical regions of momentum space. The two-body scattering amplitudes are multiplied by functions of momentum that either suppress or enhance their contribution whenever a momentum argument exceeds a cutoff value. Binding energies and particle-bound-pair elastic scattering phase-shifts below the break-up threshold are shown as functions of the cutoff values. The most critical region is for both momentum variables between 0 and about 2 inverse fermis. There is no discernible contribution from two-body scattering amplitudes with a momentum variable greater than 5 inverse fermis. Several separable potentials, including some with repulsion, are used in establishing this result, which is contrary to expectations from nuclear matter calculations. Possible reasons for this discrepancy are discussed. Local potentials are used in an investigation of three-nucleon binding energies for phase-shift equivalent potentials. These are generated through radial distortion unitary transformations on a sum of two Yukawa potentials. The transformed and the untransformed potentials all lead to approximately the same ground-state energies, which is surprising in the light of prior nuclear matter calculations. The ratio method of Malfliet and Tjon is discussed in detail and is used to obtain some of the binding energies. This method breaks down for several of the transformed potentials, so Padé approximants are used to find their ground states. The numerical difficulties that are encountered indicate that it is probable that scattering calculations with local potentials will have similar problems. Thus, extensive preliminary investigations of any proposed method are needed. (Diss. Abstr. Int., B)

32453 NEUTRON–PROTON CORRELATION EFFECTS IN MEDIUM WEIGHT SPHERICAL NUCLEI. Chen, Hsi-tseng. New York; New York Univ. (1971). 191p. University Microfilms Order No. 72-13,341.
Thesis.

The effects of the neutron–proton pairing correlations on the low-energy properties of medium weight nuclei are studied. The charge-independent pairing Hamiltonian, spanning several single particle states, is used as a schematic model Hamiltonian in which the residual interaction is effective in the J = 0, T = 1 states of the two nucleon system. Instead of using any approximation, the Schrödinger equation for the nuclear many-body system is solved exactly using group theory and algebraic analysis. The calculation of the states is reduced to the solution of a set of coupled equations which depend parametrically upon the symmetry constants that characterize the symmetry of the state under charge exchange among the J = 0 pairs. The total energy of the system is then given by the sum of the roots of these equations. The above-mentioned symmetry constants are expressed analytically, using group ring theory, in terms of the total isospin and the nucleon number for the states of the greatest physical interest. The system of coupled equations is then solved numerically by the method which makes the exact calculation of the pairing Hamiltonian as practical as that of BCS approximation. The model is applied to ^{64}Zn and ^{65}Zn. The two close-lying O$^+$ excited states in the observed spectra of ^{64}Zn, which have thus far defied explanation, can be explained by this theory. As for ^{65}Zn, several seniority-one states up to about 2 MeV in the observed level scheme are suggested. These results do show that the states with intermediate charge symmetry are important in the interpretation of the observed spectra of these nuclei, and also that the neutron–proton pairing plays an active role in these nuclei. A newly-proposed approximation for treating T = 1 pairing is derived from the coupled equations and proves useful in the study of the neutron–proton pairing vibrations. Bohr's pairing vibration scheme is reproduced by a simple calculation for the ^{56}Ni. The result seems to indicate that the neutron–proton pairing vibrations result from both the (T = 1) force and the isopairing (T = 0) force. (Diss. Abstr. Int., B)

32454 PARTICLE–GAMMA ANGULAR CORRELATIONS FOLLOWING NUCLEAR REACTIONS INDUCED BY A POLARIZED BEAM. **Debenham, A. A. (Univ. of Birmingham, Eng.); Satchler, G. R. Particles Nucl.; 3: No. 3, 117-24(Mar 1972).**

A general formalism, based upon the phase-consistent treatment of Rose and Brink, is presented for particle-gamma angular correlations following reactions induced by polarized incident particles. The symmetry properties of the correlation are discussed. Some special cases are mentioned briefly. (auth)

32455 OPERATIONAL TESTS OF PERTURBATION THEORY USING MAGNETIC PROPERTIES OF NUCLEI. **Goode, Philip; Zamick, Larry (Rutgers–The State Univ., New Brunswick, N. J.). Particles Nucl.; 3: No. 3, 125-39(Mar 1972).**

The magnetic properties of singly magic nuclei, in particular the N = 28 isotones, are considered. An effective one-plus two-body magnetic-moment operator is constructed to simulate configuration mixing in first order perturbation theory. This operator is related to the magnetic moments of ^{54}Fe excited states. It is noted that whereas in zero order all M1 rates should vanish and all g factors should be constant, with a 2-body operator M1 rates are finite, and g factors of ground states of odd Z nuclei will vary linearly with the number of particles in the shell. M1 rates in nuclei with n particles should equal the corresponding rates in nuclei with n holes. These predictions are compared with experiment and deviations are observed. An attempt to explain the deviations is attempted, with partial success by carrying out a matrix calculation of the wave functions. The sensitivity to the force used is also studied. (auth)

32456 THEORETICAL RESULTS CONCERNING THE INTERNAL BREMSSTRAHLUNG WHICH ACCOMPANIES ELECTRON CAPTURE. **Kadar, Imre (Nuclear Research Inst., Debrecen, Hungary). Fiz. Szemle; 22: No. 1, 10-17(Jan 1972). (In Hungarian).**

Experimental study of internal bremsstrahlung is an important tool to examine nuclei which decay by electron capture. The data make it possible to check the theoretical assumptions concerning the emission of internal bremsstrahlung photons and to measure directly the total energy available for transition processes by determining the maximum energy of the internal bremsstrahlung spectrum. Knowledge of forbidden transitions helps to clarify the transitional matrix elements. The correctness of the theory may be evaluated on the basis of spectrum shape, angular distribution, angular correlation, and circular polarization measurements. Complex experimental techniques must be used in these measurements because the processes have a very low probability and interfering effects may cause serious errors. The available literature on these topics is critically examined. (71 references) (TTT)

32457 CLUSTER STRUCTURE OF LIGHT NUCLEI AND LONG-RANGE ALPHA PARTICLES. Abdinov, O. A.; Barashenkov, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., B3: No. 2, 295-8(Mar-Apr 1972). (In Russian).

It is shown that alpha particles with energies $T \geq 32$ MeV which are found in the interactions of 660-MeV protons with carbon can be interpreted as alpha clusters removed from the nucleus in the process of the development of the nuclear cascade. The study of the properties of these fast alpha particles may provide important information on the cluster structure of light nuclei. (auth)

32458 ASYMMETRIC TWO-CENTER SHELL MODEL. Maruhn, Joachim; Greiner, Walter (Univ., Frankfurt am Main). Z. Phys.; 251: No. 5, 431-57(1972).

The previously developed two-center shell model for symmetric fission has been extended to break-ups into unequal fragments. The potentials of the separate fragments have equal depth. The rounded barrier between them can have varying height. The two fragments can also have different deformations. Generalized $l \cdot s$- and l^2-terms are included. This allows for the description of a great variety of nuclear shapes. The mathematical details are presented together with the analytically solvable matrix elements. For a few asymmetric fission processes the level spectra have been calculated. (auth)

32459 THREE-ALPHA MODEL FOR ^{12}C. Zickendraht, W. (Univ., Marburg, Ger.). Z. Phys.; 251: No. 5, 365-74(1972).

It is shown how the Pauli principle can be taken into account for cluster model calculations with two clusters in a very simple way. The effect of the Pauli principle shows up in the interaction of the clusters which has the form of a two particle central interaction. With no special assumption about this interaction it is expanded in an orthogonal system, of which three terms are taken into account. The parameters in this expansion are determined from the positions of the energy levels. Two possible fits are given. (auth)

32460 EQUILIBRIUM PAIRING IN SOME SPHERICAL NUCLEI. Balbutsev, E. B.; Bochnacki, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., B3: No. 2, 283-5 (Mar-Apr 1972).

Equilibrium pairing energy gaps for nuclei with $42 < Z < 56$ and $52 < N < 58$, $68 < N < 88$ are calculated by the total energy minimum method. The results are compared with the experimental odd—even mass differences. (auth)

32461 TWO-STEP PROCESSES AND ANGULAR CORRELATION STUDIES IN DEUTERON STRIPPING REACTIONS ON DEFORMED NUCLEI. Bindal, Pawan Kumar. Athens, Ohio; Ohio Univ. (1971). 187p. University Microfilms Order No. 72-9571. Thesis.

Nuclear stripping reactions on deformed nuclei have usually been treated as one-step processes leading directly from the ground state of the target nucleus to the final state in the residual nucleus. Recently it has been suggested by several authors that higher-order processes may play an important role. A perturbation approach is used to expand the transition amplitude in terms of β, the deformation parameter. In this formalism, in addition to the direct stripping reaction term or the one-step process term, the first order terms which are the two-step process terms are included. These two-step process terms correspond to the virtual excitation of the target nucleus followed by the stripping to the exit channel and to the virtual excitation of the collective modes of the residual nucleus after stripping. All the different angular momentum transfers allowed by the selection rules are included. Three-step processes are neglected in the present analysis. This formalism was used to analyse the ^{24}Mg(d,p)^{25}Mg(g.s., $5/2^+$) and the ^{24}Mg(d,p)^{25}Mg(1.61, $7/2^+$) reactions with $E_d = 15$ MeV and the ^{182}W(d,p)^{183}W(g.s., $1/2^-$), ^{182}W(d,p)^{183}W(0.46, $3/2^-$) and the ^{182}W(d,p)^{183}W(0.99, $5/2^-$) reactions with $E_d = 12$ MeV. The calculations for the ^{24}Mg(d,p)^{25}Mg(g.s.) reaction and the stripping reaction on W leading to the $3/2^-$ and $5/2^-$ states show that the two-step processes increase the cross-section by 10—15%, at the most. These transitions are allowed in the one-step process. Calculations for the ^{24}Mg(d,p)^{25}Mg(1.61, $7/2^+$) reaction show that the contribution from the inelastic scattering effects in the exit channel dominates over the contributions from the inelastic scattering effects in the entrance channel. The results seem to fit the available experimental data for this reaction. Calculations for the deuteron stripping on ^{182}W leading to $1/2^-$ ground state of ^{183}W show that the contributions from the effects of the inelastic scattering in the entrance channel and the exit channel are about equally important. The inclusion of the two-step processes in the entrance as well as the exit channels changes the shape and increases the cross-section. The increase in the cross-section is by as much as a factor of four to fifteen. The shape and the magnitude of the cross-section calculated for this transition agree with the experimental data. A theory for angular correlation in stripping reactions on odd-A or odd-odd A deformed nuclei is also given. In this theory, the effects of more than one l-value transfer and also the effects of band mixing caused by the Coriolis coupling are included. (Diss. Abstr. Int., B)

32462 (γ,N) REACTIONS THEORY AT ENERGIES ABOVE THE PION PRODUCTION THRESHOLD. Akhiezer, I. A.; Barts, B. I. (Physical-Technical Inst., Kharkov). Yadern. Fiz.; 15: No. 2, 251-7(Feb 1972). (In Russian).

Photonuclear reactions followed by proton production are studied theoretically at energies above the pion production threshold. A reaction $\gamma A \rightarrow A'p\pi$ gives an essential contribution to the (γ,p) cross section in this energy region. The cross section of this reaction is calculated with the momentum approach in the Fermi gas model with self-consistent interaction. The dependence of the cross sections on parameters characterising the nuclei is investigated. The theoretical results are compared with known experimental data. (auth)

32463 TWO-STEP PROCESS IN DIRECT (d,t) REACTION IN RARE-EARTH NUCLEI. Jaskola, M.; Kozlowski, M. (Inst. of Nuclear Research, Warsaw. Univ., Warsaw). Acta Phys. Pol., B3: No. 2, 299-306(Mar-Apr 1972).

The two-step model of the (d,t) direct reaction in rare-earth nuclei is investigated. The inclusion of the strong coupling in the entrance and exit channels improves the agreement of theoretical angular distributions with experimental data, although a discrepancy in absolute strengths remains. (auth)

32464 CALCULATION OF NEUTRON EQUILIBRIUM PAIRING IN SPHERICAL SINGLE CLOSED SHELL NUCLEI. Balbutsev, E. B.; Bochnacki, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., B3: No. 2, 287-94(Mar-Apr 1972).

Neutron pairing in Ni, Sn, and Pb isotopes is calculated by minimalization of the total energy under the condition of constant volume. Satisfactory over-all agreement with experimental pairing parameters is found in all three cases. (auth)

32465 EXTENSION OF THE THERMODYNAMIC THEORY OF HAGEDORN TO (PROTON + NUCLEUS) INTERACTIONS; COMPARISON WITH EXPERIMENTAL RESULTS. Alard, J. P. (Univ., Clermont-Ferrand, France); Avan, Louis; Avan, Madeleine; (and others). Compt. Rend., Ser. B; 274: No. 4, 286-9 (24 Jan 1972). (In French).

The thermodynamic theory of Hagedorn is applied to the interactions between energetic protons and nuclei; the partition function is calculated taking into account the fast light fragments ejected; predictions concerning the energy spectra are compared with the experimental results. (France)

PHYSICS (PLASMA AND THERMONUCLEAR)

32466 (AEC-tr-7305) PLASMA PHYSICS AND CONTROLLED THERMONUCLEAR REACTIONS, 1968 TO 1969. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Sukhumi. Fiziko-Tekhnicheskii Institut). Translation of report NP-18901. 330p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 38323. (M.O.W.)

32467 (NYO-3077-185) ABSTRACTS OF SHERWOOD THEORETICAL MEETING, MARCH 22-23, 1971. (New York Univ., N. Y. Courant Inst. of Mathematical Sciences). 1 Dec 1971. Contract AT(11-1)-3077. 67p. (MF-65). Dep. NTIS.

Abstracts are given for 54 of the talks presented at the conference. A status report was given by a representative from each National Laboratory. The conference, as a whole, tended to be concerned with the various instabilities associated with fusion plasmas. (M.O.W.)

32468 PHENOMENA IN IONIZED GASES, 1971. Tenth International Conference, Oxford, England, September 13-18, 1971. Invited Papers. Davenport, P. A. (ed.). Oxford; Donald Parsons and Company Ltd. (1971). 461p. Pound 12. (CONF-710920).

The 14 invited papers were in NSA Scope, and separate abstracts were prepared for each. Short communications covering the 440 contributed papers are presented in a second volume. (UK)

For abstracts of individual papers see: 31867, 31960, 31992, 31993, 32490, 32499—32502, 32533, 32534, 32540, 32587, and 32588.

Confinement and Heating

32469 (ORNL-TM-3788) ENERGETIC PARTICLE BEAMS AND FUSION DEVICES. Forsen, H. K. (Wisconsin Univ., Madison); Stewart, L. D.; Stirling, W. L. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 15p. Dep. NTIS.

Energetic neutral beams are being considered both for filling and heating fusion devices. Rough estimates of beam current and energy are derived for open and closed magnetic geometries. In addition, the use of beams to effect energy multiplication schemes or stationary tokamak experiments are briefly summarized. The problems of neutral-beam production as a function of beam energy and ion specie is also discussed. The state of the art for ion-beam production at ORNL concludes the report. (auth)

32470 (TRITA-EPP-71-18) HIGH-DENSITY PLASMA CONFINEMENT IN POLOIDAL MAGNETIC FIELDS. Lehnert, B. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). 14 Aug 1971. 55p. Dep. NTIS (U. S. Sales Only).

The theoretical background as well as obtained experimental results and future plans of the Swedish fusion research program are reviewed. The specific problems of high-density plasma confinement in internal ring and rotating plasma devices are treated, including plasma generation, plasma balance, confinement schemes, stability, plasma heating, plasma diagnostics, and part of the reactor technological problems involved. (auth) (Sweden)

32471 (UCRL-51208) INITIAL OPERATION OF THE 2XII EXPERIMENT. Coensgen, F. H.; Cummins, W. F.; Nexsen, W. E. Jr.; Simonen, T. C. (California Univ., Livermore. Lawrence Livermore Lab.). 10 Mar 1972. Contract W-7405-eng-48. 34p. Dep. NTIS.

Typical examples of plasma containment observed in the first high vacuum operation of the plasma-injected, open-ended, minimum-B 2XII experiment are discussed. The density decay curves for plasmas in which the velocity function had a single maximum exhibited no periods of abrupt plasma loss or other obvious evidence of plasma turbulence (instability). For this example, the observed value of $n\tau$ at 10^{13} cm^{-3} was approximately one-third that calculated for ion-ion scattering by a two-dimensional computer code. As the density fell to 10^{12} cm^{-3}, this discrepancy approximately doubled. In examples exhibiting periods of plasma turbulence and rapid plasma loss, there is evidence that the plasma instabilities were driven by the presence of two or more maxima in the ion velocity functions. (auth)

32472 PORT PLUG FOR A PLASMA-CONFINING CAVITY. Lien, Neil C. (to United States Atomic Energy Commission). U. S. Patent 3,650,893. 21 Mar 1972. Filed 2 Dec 1969.

This body that defines a cavity confining a plasma in a partial vacuum includes an inwardly tapering conical aperture permitting access to the cavity and a truncated-conical plug sized to engage the aperture in removable-deformable fit engagement a distance along the length of the aperture from the cavity-defining interior walls of the body greater than the resistive skin depth of the body. The plug is further sized to seal the cavity flush with the interior walls of the body and the sides of the plug and the conical aperture are generated at an angle θ relative to the vertical such that θ has a value less than $\tan\theta = 1/\mu$ and greater than $\tan\theta = \mu$, wherein μ is the coefficient of static friction between the plug and the body. (auth)

32473 TURBULENT HEATING AND RESISTIVITY IN COOL-ELECTRON θ-PINCHES. Krall, Nicholas A.; Liewer, Paulett C. (Univ. of Maryland, College Park). Phys. Fluids; 15: No. 6, 1166-8(Jun 1972).

The turbulent behavior observed in several cool electron ($T_e \lesssim T_i$) experiments is explained by intermediate-frequency, long-wavelength modified two-stream and drift instabilities. (auth)

32474 QUASI-LINEAR DIFFUSION OF AN AXISYMMETRIC TOROIDAL PLASMA. Kaufman, Allan N. (Univ. of California, Berkeley). Phys. Fluids; 15: No. 6, 1063-9(Jun 1972).

In a toroidal plasma with axial symmetry, the three adiabatically invariant actions of a particle are the magnetic moment, the canonical angular momentum, and the toroidal flux enclosed by the drift surface. Resonant interactions between particles and the normal modes of collective oscillation produce mode growth or decay and random changes in the actions. This random walk is represented by a diffusion equation in action space. Both the diffusion tensor and the growth rate depend upon a coupling coefficient which represents the work done by a normal-mode field eigenfunction on the current density of an unperturbed particle orbit. The diffusion of the plasma causes adiabatic changes in the electric and magnetic self-consistent fields. Accordingly, energy is not conserved, but is exchanged with external currents. (auth)

32475 EARLY DEPARTURE FROM FREE ACCELERATION AND TURBULENT HEATING OF ELECTRONS IN A TOROIDAL EXPERIMENT. Hirose, A.; Mah, S. Q.; Skarsgard, H. M.; Strilchuk, A. R.; Whitfield, D. W. A. (Univ. of Saskatchewan, Saskatoon). Phys. Rev. Lett.; 28: No. 18, 1185-8(1 May 1972).

Shortly after initiation of a high-voltage toroidal discharge in Ar, departure from free-electron acceleration is observed, together with electron heating such that the total energy input is accounted for. This early behavior is attributed to a high-frequency instability ($\omega_{pi} < \omega < \omega_{pe}$) due to interaction between relatively few trapped electrons and the streaming electrons. (auth)

32476 HIGHER-TEMPERATURE LIMIT FOR TURBULENT HEATING OF PLASMA BY A CROSS-FIELD CURRENT. Hirose, A.; Alexeff, Igor (Univ. of Tennessee, Knoxville). Contract AT(40-1)-4211. Phys. Rev. Lett.; 28: No. 18, 1176-9(1 May 1972).

In theoretical and experimental studies of high-frequency ($\omega_{ci} \ll \omega \lesssim \omega_{pi}$) ion heating by electrostatic instabilities driven by a current perpendicular to both a density gradient and an external magnetic field, one instability is found to remain active for a current velocity smaller than the ion thermal velocity. For one experiment, the level of turbulence, effective ion collision frequency, and ion heating rate are also estimated. (auth)

32477 EXPERIMENTAL INVESTIGATION OF TURBULENT PLASMA HEATING BY STRAIGHT-DISCHARGE SKIN CURRENT. Aranchuk, L. E.; Zavoiskii, E. K.; Lin, D. N.; Rudakov, L. I. JETP Lett. (USSR) (Engl. Transl.); 15: No. 1, 22-4(5 Jan 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 1, 33-6(5 Jan 1972).

The experiments were performed with the TN-5 Probkotron mirror machine under conditions when the plasma-heating current was strongly concentrated in the skin layer. Diagrams show the radial distribution of the azimuthal magnetic field measured with probes at different instants of the discharge. Diagrams also show the distribution of current density over the plasma cross section at 2.0 μsec after the start of the discharge. (M.O.W.)

32478 ELECTRON-CYCLOTRON HEATING IN THE TOKAMAK TM-3 INSTALLATION. Alikaev, V. V.; Bobrovskii, G. A.; Ofitserov, M. M.; Poznyak, V. I.; Razumova, K. A. JETP Lett. (USSR) (Engl. Transl.); 15: No. 1, 27-30(5 Jan 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 1, 41-4(5 Jan 1972).

Using the Tokamak TM-3 installation, the possibility of additionally heating a plasma in a hf field in the frequency range of the electron cyclotron resonance and its harmonics was studied. Diagrams are given for ratios of power absorption to power input versus the ratios of electron cyclotron frequency to generator frequency. Electron temperature plots are given. The heating efficiency is discussed. (M.O.W.)

32479 PLASMA HEATING BY HF FIELD OF ION CYCLOTRON FREQUENCY. Shvets, O. M.; Kurilko, P. I. Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 12, 1791-4(1971). (In Russian).

The heating of plasma by means of a coil in which the ion cyclotron frequency current flows is theoretically investigated; hf-field distribution over the plasma volume is found. The plasma heating is shown to be realized only in the case of large geometrical dimensions. The power absorbed by the plasma is calculated and the power is also estimated for concrete parameter values. (auth)

Diagnostics

Refer also to abstracts 31920, 31948, and 32537.

32480 (KHFTI-71-22) THEORY OF ELECTROSTATIC PROBES IN A RETARDING-POTENTIAL METHOD. Aleksin, V. F.; Bocharov, V. G. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1971. 30p. (In Russian). Dep. NTIS (U. S. Sales Only).

Passage of charged particles of a plasma, with random equally probable phases of rotation, about a Larmor circle through a circular aperture and a slit of arbitrary dimensions and located in a homogeneous magnetic field perpendicular to the plane of the diaphragm was studied. Expressions are obtained for the probability of passage of the particles as a function of their positions and velocities. Using this information, a transmission function related to the distribution function of plasma particles in front of and behind the diaphragm is calculated. The essential effect on the particle distribution function in the previous beam derives from the diaphragm thickness and transverse dimensions that are equal to or less than the helical spacing and the Larmor radius of the charged-particle trajectory. (tr-auth)

32481 (NP-19262) SPECTROSCOPIC EXAMINATION OF THE PARAMETERS OF A TURBULENT PLASMA. Berezin, A. B.; Dubovoi, L. V.; Lyublin, B. V.; Yakovlev, D. G. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

Parameters of highly turbulent plasma were studied. Two branches of oscillations in the discharge are found. Basic characteristics of oscillations are estimated by the profile shape of the H_β hydrogen spectral line. In the present experiment, the strength of the E fields of the turbulent pulsations is $\simeq 6$ kV/cm. The turbulence level is $\epsilon = (E^2/8\pi nT) \approx 10^{-4}$. The degree of oscillation anisotropy is $(E_{||}/E_{\perp}) \simeq 3$. (auth)

32482 (NP-19284) DETERMINATION OF PLASMA DENSITY IN STELLARATORS USING AN OPEN MICROWAVE RESONATOR. Preprint No. 25. Akulina, D. K.; Nechaev, Yu. I.; Sud'enkov, V. Ya.; Fedyanin, O. I. (Akademiya Nauk SSSR, Moscow. Fizicheskii Institut). 1972. 6p. (In Russian). Dep. NTIS (U. S. Sales Only).

Measuring resonators with high Q must be used in the measurement of plasma density in a wide range. Fabry–Perot-type open microwave resonators possess the required characteristics, but their use in stellarators encounters difficulties associated with resonator placement within the chamber without constricting its aperture. This and similar problems were satisfactorily solved for the measurement of plasma densities, and also for the measurement of resonance frequency shift. The apparatus for these measurements is diagrammed and discussed. (K.S.W.)

32483 CO_2 LASER SCATTERING MEASUREMENTS OF TURBULENCE IN A HIGH-β COLLISIONLESS SHOCK WAVE. Kornherr, M.; Decker, G.; Keilhacker, M.; Linderberger, F.; Roehr, H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Phys. Lett.; 39A: No. 2 95-7 (24 Apr 1972).

Long wavelength ($\lambda = 0.01$ cm) suprathermal (3×10^4 times thermal) density fluctuations are observed in a collisionless shock wave by scattering of CO_2 laser light. The fluctuations first propagate parallel to the electron drift, 20 ns later in a perpendicular direction as well. (auth)

32484 MULTICHANNEL INTERFERENCE FILTER SPECTROMETER USED IN THOMSON SCATTERING MEASUREMENTS ON A PLASMA. John, P. K.; Ng, K. H. (Univ. of Western Ontario, London). J. Phys., E (London); 5: No. 4, 322-5(Apr 1972).

The operation of a six-channel interference filter spectrum analyzer used in laser scattering measurements on a pulsed plasma is described. The spectral resolution of the system was 6 Å and the width of the spectrum measured was about 50 Å. The image dissector, which directed the dispersed light to the six photomultipliers, was a transmitting-type multiprism made of clear plastic. (auth)

32485 DETERMINATION OF SPATIAL AND TEMPORAL ELECTRON DENSITY AND TEMPORAL ELECTRON TEMPERATURE IN LASER-PRODUCED GASEOUS DEUTERIUM PLASMAS. Pendleton III, Winston Kent. Wright-Patterson AFB, Ohio; Air Force Inst. of Tech. (1971). 123p. University Microfilms Order No. 72-12,904.

Thesis.

The temporal and spatial electron density distribution and the temporal variation of electron temperature were determined in gaseous deuterium plasmas produced by a laser. In addition to these measurements, made during laser irradiation of the plasma, the plasma growth rate, laser-plasma absorption and reflection interaction, and pressure dependence of laser intensity breakdown threshold were determined. The laser intensity breakdown threshold is shown to have a nearly inverse pressure dependence establishing the dominance of pulse duration over diffusion or recombination in the attainment of breakdown. Asymmetric growth rates of 4×10^7 cm/sec away from the laser coupled with a maximum of 16% energy absorption are shown not compatible with any existing plasma growth model. Electron densities corresponding to 25% ionization (4×10^{18} to 1×10^{19} electrons/cm^3) and electron temperatures of 4×10^5°K shows the plasma as a whole to be highly nonequilibrium, even though the electrons and deuterons remain respectively thermalized. The refractive and reflective effects of the plasma boundary were calculated and reflection was determined as responsible for the strong ruby emissions observed at 90°. A time-variable reflectivity (TVR) ruby laser with a pulse duration of 4 nsec was employed in these experiments at gas pressures from 100 to 600 torr. The electron density and temperature measurements represent a major addition to the data available on laser-produced plasmas. (Diss. Abstr. Int., B)

32486 LASER SCATTERING FROM HIGH-DENSITY LOW-TEMPERATURE PLASMAS. Kato, Masao. College Park, Md.; Univ. of Maryland (1971). 80p. University Microfilms Order No. 72-12,729

Thesis.

Spectra of laser light scattered from a hydrogen plasma produced in a 6-kJ theta pinch were investigated under two conditions: (1) there were only two electrons in the Debye volume where the usual scattering theory is dubious, and (2) there were twelve electrons in the Debye volume, where the scattering theory can be considered to be valid. Both spectra were compared with the spectra predicted by the usual theory using plasma parameters obtained by the techniques of plasma spectroscopy. Comparison between the plasma parameters determined from scattered light and those deduced from spectroscopic measurement was also made. It was found that they agreed within the experimental errors. The spectroscopic determination of plasma parameters, i.e., electron density and temperature, was made from the H_β line, the continuum radiation, and the ratio of the H_β line to the continuum radiation. The results support the validity of the usual scattering theory under conditions where there are as few as two electrons in the Debye volume and, in turn, demonstrate agreement between the laser scattering and spectroscopic plasma diagnostic techniques. (Diss. Abstr. Int., B)

32487 EFFECT OF IMPURITIES AND THE HETEROGENEITY OF A PLASMA ON THE MEASUREMENT OF ITS ELECTRON TEMPERATURE. Decroisette. M.; Piar, G. (Centre d'Etudes de Limeil, Villeneuve, France). J. Quant. Spectrosc. Radiative Transfer; 12: No. 4, 587-601(Apr 1972). (In French).

The effect of impurities on soft x-ray continuum radiation emitted from a high-temperature deuterium plasma was studied. The results of these calculations are useful in the determination of the electron temperature of a laser-created plasma. Such a plasma is inhomogeneous and contains impurities. (auth)

32488 MEASUREMENTS OF LASER-PRODUCED PLASMAS FROM LITHIUM TARGETS BY RETARDING-POTENTIAL PROBE. Matoba, Tohru (Kyoto Univ.). Jap. J. Appl. Phys.; 11: No. 5, 770-1(May 1972).

The retarding-potential probe is described. Three mesh grids, each of which is composed of 40-μ-diameter brass wires with 40-μ aperture, are placed a distance of 2.5 mm. The first grid and the second are so arranged to stop electrons from the plasma, and the third to suppress secondary electrons emitted from the collector. Retarding potential is applied to the collector. Typical collector signals are described. (M.O.W.)

32489 MULTICHANNEL ENERGY ANALYSIS OF IONS AND FAST CHARGE-EXCHANGE ATOMS IN THE INVESTIGATION OF A HIGH-TEMPERATURE PLASMA. Koidan, V. S. (Inst. of Nuclear Physics, Novosibirsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 725-8(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 63-6(May-Jun 1971).

A method of multichannel analysis of ions and fast atoms exiting from a high-temperature plasma is described. The fast atoms are ionized in a gas stripping chamber. The ions are analyzed with respect to energy by means of a 9-channel analyzer. Energy separation occurs in uniform electric fields at an angle of incidence of the charged particles equal to 45°. Ion–electron converters combined with scintillation ion-current detectors ensure high time resolution of the instrument and a current sensitivity $\sim 10^{-12}$ A. The system was used to investigate the heating of ions in a turbulent plasma. (auth)

32490 ADVANCES IN PLASMA DIAGNOSTICS WITH WAVES AND RADIATION. Bekefi, G. (Massachusetts Inst. of Tech., Cambridge). pp 299-332 of Phenomena in Ionized Gases, 1971. /Davenport, P. A. (ed.). Oxford; Donald Parsons and Co. Ltd. (1971).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

Recent studies of nonlinear wave–wave coupling, scattering, and radiation in plasmas are described, and manifestation of these processes in thermal and turbulent media is discussed. Relevance of the experimental work to plasma diagnostics is indicated. Headings are as follows: nonlinear wave–wave coupling (coupling of acoustic waves; optical mixing and other interactions; magnetic field effects in scattering from plasma fluctuations); radiation (bremsstrahlung from collective fluctuations; optical transitions stimulated by plasma turbulence; anomalous line-broadening caused by turbulence; forbidden optical transitions; and determination of radiation temperature). (74 references) (UK)

Kinetics (General)

32491 (N–72–12743) DEVELOPMENT AND INITIAL OPERATING CHARACTERISTICS OF THE 20-MEGAWATT LINEAR PLASMA ACCELERATOR FACILITY. Carter, Arlen F.; Weaver, Willard R.; McFarland, Donald R.; Wood, George P. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Dec 1971. 34p. (NASA-TN-D–6547; L–7932). NTIS.

A 20-MW linear plasma accelerator facility, a steady-flow, Faraday-type plasma accelerator facility for high-velocity aerodynamic testing, was constructed, developed, and brought to an operational status. The accelerator has a 63.5 mm-square and 0.5-meter-long channel and utilizes nitrogen-seeded with 2% mole fraction of cesium vapor. Modification of the original accelerator design characteristics and the improvements necessary to make the arc heater a suitable plasma source are described. The measured accelerator electrode current distribution and the electrode-wall potential distributions are given. The computed and the measured values are in good agreement. Measured pitot pressure indicates that an accelerator exit velocity of 9.2 km/s, is obtained with 30 of the 36 electrode pairs powered and corresponds to a velocity increase to about 2¼ times the computed entrance velocity. The computed stagnation enthalpy at the accelerator exit is 92 MJ/kg, and the mass density corresponds to an altitude of about 58 km. The 92 MJ/kg stagnation enthalpy corresponds to a kinetic energy content at low temperature equivalent to a velocity of 13.6 km/s. (auth) (STAR)

32492 (TRITA-EPP–71–28) LABORATORY EXPERIMENT ON THE INTERACTION OF A FAST PLASMA STREAM WITH UNMAGNETIZED BODIES. Kristoferson, Lars (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Sep 1971. 26p. Dep. NTIS (U. S. Sales Only).

Results are presented for an experiment on the interaction between a supersonic plasma stream and unmagnetized spherical bodies with different conductivities. Streaming conditions around the bodies are investigated. Amplification of magnetic fluctuations from the plasma are studied for a two-layered body, and good agreement is obtained with a simple theory. The results are compared with recent observations of the solar wind–moon interaction. (auth) (Sweden)

32493 LIMITING THE RADIAL EXPANSION OF ARC CURRENT BY AN AXIAL MAGNETIC FIELD. II. SCALING LAWS AND COMPARISON WITH EXPERIMENTS. Klueber, O. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch.; 27a: No. 4, 652-70(Apr 1972). (In German).

In an arc with superimposed axial magnetic field, radial current components cause a rotational motion of the plasma column and produce azimuthal Hall currents and hence electromotive forces such that the arc current is guided by the magnetic field lines. The steady-state plasma equations have been solved for a homogeneous plasma in simple geometry, allowance being made for finite viscosity. Here, scaling laws giving the radial extent of the arc current are obtained. In addition, electrodes with finite cross sections are treated. The results of model calculations agree with experimental data. Generally, the model is applicable, if the angular frequency of the plasma is small compared with the ion gyration frequency. (auth)

32494 MAXWELLIAN DISTRIBUTION OF ELECTRONS WITH RESPECT TO ENERGY IN THE GAS-DISCHARGE PLASMA IN NITROGEN. Vasil'ev, S. S.; Rode, S. V. (Moscow Technological Inst. of the Light Industry). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 11, 1687-8(Nov 1971).

Translated from Zh. Fiz. Khim.; 45: No. 11, 2971-2(Nov 1971).

A diagram relating the electron distribution with respect to energy is discussed. The distribution function curve associated with the diagram is given. It is assumed that the maximum of this curve represents the Maxwellian distribution of electrons for the same most probable energy. The form of this distribution is described. (M.O.W.)

32495 ELECTRON SHEATH EXTRACTION OF IONS FROM A PLASMA. Grodzinsky, Stephen Eugene. Urbana, Ill.; Univ. of Illinois (1971). 105p. University Microfilms Order No. 72-12,183.

Thesis.

The electron sheath extraction of ions from a plasma is investigated. The sheet beam which is derived from a Pierce-type electron gun is passed over a plasma. A magnetron discharge, which utilizes crossed electric and magnetic fields in such a way as to increase the probability of electron–neutral collisions, is the source for the plasma. Argon is used as the working gas. The sheet beam acts in much the same way as a mesh electrode does but with several advantages. That is, the beam provides a potential which is negative with respect to the plasma which attracts plasma ions but repels plasma electrons. Since the beam effectively "sees" only a Debye length into the plasma, ions in this region are extracted. Other ions deeper into the plasma then diffuse into this region and are eventually extracted themselves. The advantages of using this technique include the fact that there is no grid that will be sputtered away. Also, because the ions are free to pass through the sheet beam, there is less chance of disruptive voltage breakdown between the extraction "electrode" and the plasma. It is seen that as the plasma becomes more dense, greater ion currents may be extracted. This occurs because there are more available ions to be collected. As the argon pressure is increased at constant (magnetron) electron energy, more ions are extracted until those electrons can no longer effectively ionize the neutrals. This occurs because at a high enough pressure the electrons lose energy through a greater number of collisions and are not able to acquire a high enough potential. This is alleviated by increasing the magnetron voltage which supplies more energy to the ionizing electrons. Thus, an increased number of ions may be extracted as the plasma is made more dense. Ion currents of up to 10 mA were extracted in this manner. (Diss. Abstr. Int., B)

32496 FREE–FREE BREMSSTRAHLUNG RADIATION FROM A RELATIVISTIC PLASMA HAVING AN ANISOTROPIC ELECTRON ENERGY DISTRIBUTION. Greene, David Graham Silliman. Madison, Wis.; Univ. of Wisconsin (1971). 238p. University Microfilms Order No. 72-2633.

Thesis.

Methods are developed for determining an electron energy distribution function that may be used to represent a plasma. Several theoretical criteria are established by which the various distribution functions might be judged, namely: the plasma is anisotropic, contains relativistic electrons, and may be considered to be in quasiequilibrium. Several distribution functions are found that meet these criteria. In order to select the most appropriate distribution for a particular plasma, experimental measurements are made. The particular case chosen is that distribution found in a plasma produced by electron cyclotron resonance heating techniques and contained in a pair of magnetic mirrors. The measurements used to determine the distribution are of three types: (1) measurements made far from the plasma on particles that have escaped axially through the mirror throats; (2) measurements of the radial and axial x-ray spectra; and (3) measurements of the polarization of the radial x rays. The data resulting from these measurements are processed so that a distribution function is finally determined for this particular plasma. All of these measurements give results that are consistent with one model of the plasma: namely, a loss-cone distribution. The angle of the loss cone is determined by the mirror ratio. The electrons in the distribution have a characteristic temperature of between about 20 and 30 keV when they are located in the heating zone, and about half this temperature when they are located in the remaining volume. (TSS) (Diss. Abstr. Int., B)

32497 INVESTIGATION OF THE $1s_5$ METASTABLE ATOM DENSITY IN AFTERGLOW PLASMAS IN NEON. Wisniewski, Ernest Edmund. Urbana, Ill.; Univ. of Illinois (1971). 57p. University Microfilms Order No. 72-12,441.

Thesis.

Investigations of the neon $1s_5$ ($^3P_2$) atom density in afterglows in neon and helium–neon and under conditions of electron heating are described. Interferometric studies at 6401 Å of the spatial and temporal behavior of the Ne ($1s_5$) density in pulsed plasmas indicated that the metastable concentration attains a maximum in the early afterglow. Measurements indicated that the electron density profile underwent a rapid relaxation during the interval in which both the sidelight and $1s_5$ atom density were observed to be increasing. These phenomena were attributed to the recombination of a large population of Ne_2^+ ions which existed at the termination of the excitation interval. Estimates indicated that a large fraction of the initial electron density was converted into 1s atoms and indicated that this transformation was efficient. The $1s_5$ atom density late in the afterglow was shown to decay by known processes. However, for times immediately after attaining a maximum in the early afterglow, and under conditions of electron heating, a more pronounced decay was observed. Absorption studies of the $1s_5$ and $1s_4$ atom concentrations in neon indicated that during heating the principal decay processes for these atoms were electron collisional de-excitation to the ground state and collisional excitation to the $1s_2$ radiating state. (Diss. Abstr. Int., B)

32498 STABILITY CRITERION FOR THE BLUFF-BODY STABILIZED ELECTRODELESS ARC. Martin, R. E.; Keefer, D. R. (Univ. of Florida, Gainesville). Phys. Fluids; 15: No. 6, 1028-34(Jun 1972).

It was found that the electrodeless arc can be stabilized in the presence of flow by placing a bluff body in the entrance stream. A two-stream boundary-layer analysis, analogous to that used in combustion theory, is used to calculate an attachment length, the distance required to heat the entering stream to the arc temperature. The criterion for stability is that the attachment length is less than the length of the recirculation cell formed in the wake of the bluff body. Calculations are made for conditions typical of an atmospheric pressure arc in argon. It is found that the attachment length is approximately a linear function of the ratio of flow velocity to power density. (auth)

32499 ELECTROCHEMISTRY IN DISCHARGE PLASMAS. Polak, L. S. pp 113-91 of Phenomena in Ionized Gases, 1971. /Davenport, P. A. (ed.). Oxford; Donald Parsons and Co. Ltd. (1971).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

The subject is discussed under the following headings: special features of plasma—chemical reactions and their kinetics; fundamental equations and numerical calculations (Pauli equation); rate factor for nonequilibrium chemical reactions; some mechanisms of plasma chemical reactions (electron distribution functions influence on chemical reaction rates; chemical reactions caused by collisions with electrons and those occurring through electronically excited states); dissociative recombination of molecular ions and electrons; mixing problems; mathematical models for plasma chemical processes (chemical reactions under electromagnetic pulse conditions; chemical reactions under plasma jet conditions); plasma chemical processing (general considerations); plasma chemical processes under quasi-equilibrium conditions; plasma chemical reactions under nonequilibrium conditions. (241 references) (UK)

32500 HIGH PRESSURE GAS DISCHARGES AS INTENSE NON-COHERENT LIGHT SOURCES. Jack, A. G. (Philips Gloeilampenfabrieken, Eindhoven, Netherlands). pp 205-29 of Phenomena in Ionized Gases, 1971. /Davenport, P. A. (ed.). Oxford; Donald Parsons and Co. Ltd. (1971).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

The basic requirements for an intense light source are first briefly reviewed, together with the basic processes in the generation and emission of light. The latter include bound–bound transitions in atoms and molecules, ion electron and atom–electron free–bound transitions, free–free transitions in bremsstrahlung, radiation transfer, and line broadening. The main object of the paper is to show how efficient use may be made of these processes in various types of high-pressure gas discharges. Included are a description and analysis of arcs with atomic radiation, including the Hg arc and metal halide arcs; also, lamps making use of recombination radiation and molecular radiation are discussed. (61 references) (UK)

32501 CLUSTER IONS AND IONS WITH A SHELL STRUCTURE. Clampitt, R. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 231-57 of Phenomena in Ionized Gases, 1971. /Davenport, P. A. (ed.). Oxford; Donald Parsons and Co. Ltd. (1971).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

A cluster ion may be defined as consisting of an atomic or molecular ion to which neutral atoms or molecules are attached by virtue of an attractive inverse fifth-power polarization force. Molecules located several Å from an ion experience a field strength of $\sim 10^8$ V/cm and become polarized, and may thus become loosely bound to form a cluster ion. Following a review of earlier work in this field, the following aspects are discussed: Theoretical aspects of cluster ions; experimental studies (clustering of nonpolar molecules on ions—rare gases, hydrogen, oxygen, other gases; clustering of polar molecules on ions—water, ammonia). Cluster ions such as O_4^-, $O_2^+(O_2)_n$ and $(He^+)_n$ are well known and studied, and with the advance in ion sampling techniques, the importance of cluster ions in discharges, the radiation chemistry of gases in the upper atmosphere, have become apparent. Specific values for the clustering number, n, were determined. With small ions and large molecules, n is usually 3, 4, or 6, while for larger ions, n = 12 for a complete shell. An ion having two complete molecular shells was observed. A list of experimentally observed cluster ions is given, and systems that would make fruitful further cluster ion studies are indicated. (83 references) (UK)

32502 ROLE OF FAST PROCESSES IN VACUUM BREAKDOWN. Mesyats, G. A. (Academy of Sciences, Tomsk, USSR). pp 333-63 of Phenomena in Ionized Gases, 1971. /Davenport, P. A. (ed.). Oxford; Donald Parsons and Co. Ltd. (1971).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

After an extensive introduction to the subject of vacuum breakdown in gas electrical discharge systems, which includes a historical survey of work in this field and a consideration of hypotheses put forward to explain the mechanism of breakdown mutation and development, the following are discussed: breakdown initiation; regularities of current increase during breakdown; cathode and anode processes in breakdown; high-speed processes during breakdown at steady-voltage operation; and explosive electron emission in breakdown. (95 references) (UK)

Kinetics (Experimental)

32503 (IPP-6/103) DETERMINATION OF THE MAGNETIC FIELD B IN VACUUM FOR GENERAL TWO-DIMENSIONAL MHD EQUILIBRIA. Kerner, W.; Pfirsch, D.; Tasso, H. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Feb 1972. 10p. Dep. NTIS (U. S. Sales Only).

For general two-dimensional MHD equilibria it is possible using complex functions to obtain the solution of the vacuum magnetic field that fits the boundary conditions at the plasma surface. The solution allows to distinguish between the geometry governed and plasma magnetic field governed singularities and stagnation points. Several examples, particularly the elliptic plasma boundary case, are discussed. (auth)

32504 (NP-19255) NON-THERMAL RADIATION OF MAGNETOACTIVE PLASMA IN A FIELD OF ULTRAHIGH FREQUENCY WAVE PUMPING. Vatanov, G. M.; Sarksyan, K. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

Ultrahigh-frequency radiation from a collisionless, magnetized plasma was experimentally investigated during its interaction with a high-power pumping wave in the ultrahigh-frequency range. Red and blue satellites were observed in the spectrum of radiation in the first harmonic of the pumping wave ω_0 and were displaced relative to the central peak by $\Delta\omega \sim \omega_{Li}$. Here, ω_{Li} is the ionic Langmuir frequency, indicating the buildup of the shortest-wavelength ionic oscillations. Radiation at the second harmonic of the pumping wave $2\omega_0$ was detected, the intensity increasing exponentially with the power of the incident wave. During interaction of the plasma with the high-power wave of frequency ω_0, nonlinear gain of weak signals was observed with frequencies close to $2\omega_0$. The effects of satellite excitation were noted. Radiation at the second harmonic of the pumping wave was correlated with the effects of anomalous absorption and heating and were interpreted as parametric excitation of plasma oscillations. (tr-auth)

32505 (TRITA-EPP-71-13) REVERSE DEFLECTION AND CONTRACTION OF A PLASMA BEAM MOVING ALONG CURVED

MAGNETIC FIELD LINES. Lindberg, L.; Kristoferson, L. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Jun 1971. 11p. Dep. NTIS (U. S. Sales Only).

A plasma beam which originally moves in a longitudinal magnetic field and enters a region of curved magnetic field is investigated experimentally. It is found that the beam contracts perpendicular to the v × B direction and the whole beam becomes deflected in the direction opposite to that in which the magnetic field is curved. The deflection is caused by propagation backwards of the transverse electric field induced when the beam enters the region with curved field. (auth) (Sweden)

32506 (TRITA-EPP-71-20) GROWTH OF A SPACE CHARGE SHEATH IN A LOW DENSITY DISCHARGE PLASMA. Torven, S.; Babic, M. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Sep 1971. 15p. Dep. NTIS (U. S. Sales Only).

Surged voltage drops over a low-density mercury arc in an inductive current circuit are found to be concentrated in a space charge sheath formed within the plasma. The experimental investigations presented, which partly have been published elsewhere, aim at clarifying the conditions in the stationary plasma just before the sudden sheath growth. Some measurements during periodic sheath growth in the nonstationary plasma are also reported. The experiments are made in the positive column of a mercury arc. This plasma column is normally quiescent and a good electric conductor. Typical stationary values of the current density and the field are 10 A/cm^2 and 0.1 V/cm. When the stationary discharge current is increased sufficiently, the homogeneous electric field concentrates to a space charge sheath which separates the column in two plasmas with different properties. The sheath is unstable and the current decreases suddenly at a rate between 10^5 and 10^6 amps/sec. Sheath voltages as high as 10^5 volts, provided by the inductive current circuit, may be required to avoid current interruption and stop the current decrease. Then the voltage breaks down, and the process may repeat itself periodically. (auth) (Sweden)

32507 EXPERIMENTAL MEASUREMENTS OF FORCE-FREE COLLINEAR PLASMOIDS PRODUCED BY A CONICAL THETA PINCH. Nolting, Eugene Ellis. Coral Gables, Fla.; Univ. of Miami (1971). 213p. University Microfilms Order No. 72-12,888.

Thesis.

A description of an experimental study performed on the TRISOPS plasma device is given. The TRISOPS experiment uses two conical theta-pinch guns to heat the plasma. A brief history of the theoretical principles on which the experiment is based is presented, followed by a discussion of the new experimental work. This dissertation is divided into three parts. The first part constitutes a detailed description of the experimental device. Experimental parameters are investigated and the effect of these parameters on the plasma is described. The second part contains the study of plasma produced by a single gun. Strong experimental evidence is given to support a force-free, collinear plasma theory. The data were obtained by special magnetic and current probes, which are described in detail. Using the experimental evidence as a basis, calculations of energy density and plasma angular momentum are carried out. The calculations are shown to allow a linear scaling of plasma properties to higher energies. The third part presents the results of studies of colliding plasmoids. Experimental evidence of a deep magnetic well in the external guide field, formed by currents flowing in the plasma, is given. The size of the well as a function of experimental parameters is discussed. Use of the force-free, collinear model in discussing the observed interaction supports the model. A kinematic description of the collision describing the role of superposable states to nonlinear equations is presented. (Diss. Abstr. Int., B)

32508 STUDY OF THE FORMATIVE PHASE OF A LOW-PRESSURE HIGH-VOLTAGE Z-PINCH. MacLatchy, Cyrus Shantz. Vancouver, B. C.; Univ. of British Columbia (1971). National Library of Canada, Ottawa.

Thesis.

The formative phase of a 40-kV z pinch was investigated in the pressure range from 10 to 80 mtorr in hydrogen. The energy spectrum of the electrons on the axis of the vessel, the spatial distribution of the current at the face of the anode, the total discharge current, and the voltage across the discharge have all been monitored. For the pressures examined, the formative phase lasts a few hundred nanoseconds. (TSS) (Diss. Abstr. Int., B)

32509 COOPERATIVE ENHANCED SCATTERING FROM NONTHERMAL THETA-PINCH PLASMAS. Stainer, Howard M. (Johns Hopkins Univ., Silver Spring, Md.). Phys. Fluids; 15: No. 6, 1109-16(Jun 1972).

The conditions under which enhanced scattering of far-infrared laser radiation (337 to 119 μ) can be obtained from theta-pinch plasmas are investigated. The enhanced scattering cross-section results from above-thermal electron density fluctuations that can be produced only by nonthermal electrons in the plasma. The scattering cross section is derived for a plasma in a weak magnetic field ($\Omega_c^2 \ll \omega_p^2$) and "rigid rotor" distributions modeling the specific theta pinch plasma are used to calculate the actual cross section. The conditions under which this cross section can become greatly enhanced are then examined. Finally, various types of bremsstrahlung (free–free, magnetic, and nonmagnetic wave–wave) are compared with the scattered power. For typical laser power densities (10 W/cm^2), the plasma must be considerably nonthermal for the scattered power to be dominant. (auth)

32510 EXPERIMENTAL OBSERVATION OF OSCILLATIONS ON THE ELECTRON DISTRIBUTION FUNCTION FOLLOWING PLASMA–BEAM INTERACTION. Lavrovskii, V. A.; Shustin, E. G.; Kharchenko, I. F. (Inst. of Radio and Electronics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 15: No. 2, 57-9(20 Jan 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 2, 84-7(20 Jan 1972).

An experiment was performed with a beam–plasma discharge in hydrogen in a longitudinal magnetic field of 0.2 T with electron beam energy 1 keV at a current of 20 to 40 mA. The electrons were velocity analyzed with a grid analyzer in coaxial form, which made it possible to record the delay-current curve within a time on the order of several dozen nanoseconds. The decelerating voltage was a sawtooth pulse of 1.5 kV amplitude with a growth rate of 6×10^9 V/sec. The measurement system operated in a single-triggering regime with stationary beam injection. Diagrams of the delay current and electron velocity distribution are given. (M.O.W.)

32511 OBSERVATION OF FAST ELECTRONS PRODUCED BY INJECTION OF A PLASMOID INTO A TRANSVERSE MAGNETIC FIELD. Kartashev, K. B.; Pistunovich, V. I.; Platonov, V. V.; Ryutov, V. D.; Filimonova, E. A. JETP Lett. (USSR) (Engl. Transl.); 15: No. 1, 3-5(5 Jan 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 1, 7-9(5 Jan 1972).

The fast electrons produced when a plasmoid is injected into a transverse magnetic field were measured. The injection was along the radius of the mirror trap in its central plane. The experiments were performed under conditions when the kinetic energy density of the moving plasmoid was less than the energy density of the magnetic field. Oscillograms are given of microwave and x radiation for different experimental parameters. (M.O.W.)

32512 SOME FEATURES OF AN ELECTRON CYCLOTRON RESONANCE PLASMA PRODUCED BY MEANS OF A LISITANO COIL. Okamoto, Yukio; Tamagawa, Hajime (Nagoya Univ., Japan). Jap. J. Appl. Phys.; 11: No. 5, 726-31(May 1972).

Characteristics of an ecr plasma produced by means of an L coil are studied in changing the location of exact ecr condition on the coil. It can be seen that the energy distribution function for ions changes from double-humped to Maxwellian, and the quiescent plasma is obtained. Ion compositions of the plasma are measured as a function of electron temperature, and the chemical reactions in the plasma are discussed. (auth)

Kinetics (Theoretical)

32513 (INR-P-1367) THERMODYNAMIC FUNCTIONS OF NON-THERMAL RADIATING SYSTEMS. Suckewer, Szymon (Institute of Nuclear Research, Warsaw (Poland)). 1971. 10p. Dep. NTIS (U. S. Sales Only).

A pseudo-thermodynamic model of a system which, due to radiation leaving the system, is not in a thermodynamic equilibrium, is discussed. Thermodynamic properties of this model were pointed out. (auth)

32514 (IPP-1/124) INVESTIGATION OF THE RELATION BETWEEN COMPRESSION, RELAXATION, AND END LOSSES IN THE LATE PHASES OF THETA PINCH DISCHARGES BY MEANS OF A TWO-DIMENSIONAL MHD COMPUTER PROGRAMME. Schneider, Wolfgang (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Feb 1972. 48p. Dep. NTIS (U. S. Sales Only).

A two-dimensional MHD model was developed for the phases after the first fast compression of theta-pinch discharges. This model was tested by comparison with theoretical and experimental results; it turned out that the model aptly describes the quasi-stationary phases of theta pinches, i.e., it is suitable for predicting theta pinch experiments and, in particular, is an important aid for interpreting measurements. A detailed energy balance is made to determine quantities that cannot readily be measured and to discuss the relations between various effects. It is found that the plasma in the late phases is only adiabatically heated. The relaxation of temperature and anisotropy is discussed, particular attention being paid to interaction with heavy impurity ions and to determining the temperature of these ions from Doppler profiles of spectral lines. Finally, on the one hand, the dominant contribution of convection to the end losses is demonstrated by means of a detailed energy balance; on the other, the relevance of thermal conduction to the axial dynamics inside the coil is explained. (auth)

32515 (MATT-894) CONTRIBUTION OF COMPUTER SIMULATION TO PLASMA THEORY. Dawson, John M. (Princeton Univ., N. J. Plasma Physics Lab.). Apr 1972. Contract AT-(11-1)-3073. 18p. (CONF-720423-1). Dep. NTIS.

From first European conference on computational physics; Geneva, Switzerland (10 Apr 1972).

Recent advances in computers and in techniques for simulating plasmas have made it possible to investigate rather complicated nonlinear and turbulent phenomena in plasmas. Quite a number of problems have been investigated in recent years. Among them, anomalous absorption of intense electromagnetic waves due to the turbulence associated with parametric instabilities excited by the electromagnetic wave, the diffusion of plasma across strong magnetic fields due to thermally excited convective motion, limiting amplitudes of ion waves, and the coupling of intense plasma oscillations due to ion density fluctuations. From the simulation, one can generally gain a pretty good idea of the mechanisms involved and construct theories for the observed effects. The present status of simulation and a few examples of how it has been used to aid theory are given. (auth)

32516 (NP-19269) THETA-PINCH IN ELECTRON-HOLE PLASMA WITH SURFACE GENERATION. Vladimirov, V. V.; Koslovskaya, N. N.; Shanskii, V. F. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1971. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

A theoretical study of the theta-pinch effect in an electron–hole plasma of semiconductors was carried out for the case when the velocity of surface recombination differs from zero. Results of numerical integration of equations describing the electron–hole plasma compression in a time-increasing magnetic field are given. (auth)

32517 (NP-19291) SPECTRA OF MAGNETIC PULSATIONS OF NONISOTHERMAL PLASMA. Preprint No. 19. Livshits, M. A.; Tsytovich, V. N. (Akademiya Nauk SSSR, Moscow. Fizicheskii Institut). 1972. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

Nonlinear interactions and the spectra of magnetic pulsations of isothermal, turbulent plasma have been previously investigated by these authors. Under conditions of nonisothermal plasma, ion-acoustic oscillations arise both at low frequencies (collision-free Alfven and MHD waves), and at high frequencies (spiral waves). The spectrum of the turbulence associated with the magnetic pulsations is the subject of a theoretical study in both of the indicated frequency regions. (K.S.W.)

32518 (TRITA-EPP-72-5) ON THE BALANCE OF PLASMAS PENETRATED BY NEUTRAL GAS. Lehnert, B. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Feb 1972. 26p. Dep. NTIS (U. S. Sales Only).

There exists a critical ion density, $n_c \simeq 10^{20}\ m^{-3}$, which divides laboratory plasmas into two classes with different physical properties. At densities n less than or comparable to n_c the plasmas are permeable to penetrating neutral gas particles, whereas they become impermeable to neutrals when n is much larger than n_c. Tokamaks and stellarators belong to the former class, the maximum densities of Tokamaks being rather close to n_c. A simple model of the particle, momentum, and heat balance of permeable plasmas in Tokamaks is studied. (i) In a steady state there is essentially a fast and a slow neutral gas component present in the interior of such plasmas. The corresponding neutral gas densities are related to the plasma balance and provide an independent method of estimating the plasma diffusion rate. The neutral gas densities thus calculated from the observed energy containment time agree with the observed density values. This supports the earlier conclusion that the energy losses in Tokamaks are mainly due to anomalous plasma diffusion. (ii) The observed radial pressure distribution has steep gradients in the wall-near regions; this agrees with the present theoretical model. (iii) The observed density limit for stable operation is close to n_c. It is suggested that the change in behavior of Tokamaks near this limit is associated with the transition from permeable to impermeable plasma conditions. (auth) (Sweden)

32519 SURFACE WAVE–BEAM INTERACTION IN CYLINDRICAL GEOMETRY. Zayed, K. E. (Atomic Energy Establishment, Cairo). Physica; 58: No. 2, 315-23(15 Mar 1972).

Expressions for the components of the dielectric-permeability tensor operator for a relativistic inhomogeneous plasma stream are derived. A one-dimensional distribution function over the thermal velocities of the plasma particles is taken into account. The interaction of an electron beam with TM surface waves in a bounded plasma is considered. (auth)

32520 NUMERICAL MODELING OF LASER-PRODUCED PLASMAS: A SECOND-ORDER INTEGRATION SCHEME. Goldman, Edward B. (Univ. of Rochester, N. Y.). J. Comput. Phys.; 9: No. 2, 380-4(Apr 1972).

A numerical modeling method is described that avoids problems usually encountered in modeling of laser-produced plasmas; that is, the time scale for the transfer of energy from the electrons to the ions is much shorter than the time scale for the transport of energy by electron thermal conductivity. The method uses a second-order integration scheme to avoid this problem. The method and its use are briefly described. (M.O.W.)

32521 ELECTRON TEMPERATURE OF A PLASMA SCATTERING INTENSE LIGHT BEAMS. Vinogradov, A. V.; Pustovalov, V. V. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 3, 980-8(Mar 1972). (In Russian).

Stimulated Compton scattering of laser radiation by an electron plasma is considered. A general expression is obtained for the diffusion coefficient of electrons located in an isotropic radiation field of small spectral width. The heating rate of a Maxwellian plasma due to Compton scattering of the laser radiation and also a self-similar solution for the electron velocity distribution function are determined. (auth)

32522 NONLINEAR THEORY OF INTERACTION BETWEEN A RESTRICTED RELATIVISTIC BEAM AND A PLASMA. Krasovitskii, V. B. (All-Union Scientific Research Inst. of Electric Instruments, Kharkov). Zh. Eksp. Teor. Fiz.; 62: No. 3, 995-1005(Mar 1972). (In Russian).

A nonlinear theory of interaction between restricted relativistic beams and a plasma is developed that permits one to elucidate the main dynamic regularities of the beam particles during development of plasma–beam instability and also to determine the field amplitudes and beam radii. Limiting cases of monovelocity and quasi-linear beams are considered. (auth)

32523 THEORY OF THE ELECTRIC CONDUCTIVITY OF A TURBULENT PLASMA. Akhiezer, A. I.; Akhiezer, I. A.; Rozhkov, V. V. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 62: No. 3, 1006-9(Mar 1972). (In Russian).

The effect of ion-acoustic oscillations on the electric conductivity of a plasma is investigated in the case of a weak external electric field. It is shown that if the intensity of the ion-acoustic oscillations considerably exceeds the thermal level then the plasma electric conductivity should be considerably lower than the electric conductivity of a quiescent plasma at the same electron temperature. (auth)

32524 PLASMA CAPACITOR IN A MAGNETIC FIELD. Peratt, A. L.; Kuehl, H. H. (Univ. of Southern California, Los Angeles). Phys. Fluids; 15: No. 6, 1117-27(Jun 1972).

Expressions for the electric field and impedance of a planar capacitor containing a warm inhomogeneous magnetized plasma are derived using the electrostatic approximation. The frequency of the excitation field is near and below the second electron cyclotron harmonic while the static magnetic field is parallel to the capacitor plates. The theory, which includes wave coupling and plasma nonuniformity as well as the effects of the ambipolar electric field and the anisotropy of the unperturbed distribution function, shows that the impedance exhibits a resonant structure due to longitudinal waves confined between the two hybrid resonance points. Measurements are taken during the afterglow of a pulsed, low-pressure, argon plasma confined between planar glass walls. These measurements are found to be in good agreement with the theoretical model. (auth)

32525 HOT-ELECTRON EQUILIBRIUM IN THE CANTED MIRROR. Guest, G. E.; Hedrick, C. L.; Hogan, J. T. (Oak Ridge National Lab., Tenn.). Phys. Fluids; 15: No. 6, 1159-61 (Jun 1972).

A method for determining the distribution function of a high-β hot-electron plasma confined in a canted mirror magnetic trap is discussed and the method is applied to one experimental example. (auth)

32526 SOME ELECTROMAGNETIC PLASMA SIMULATION METHODS AND THEIR NOISE PROPERTIES. Langdon, A. Bruce

(Univ. of California, Livermore). Phys. Fluids; 15: No. 6, 1149-51(Jun 1972).

Several algorithms for incorporating the electromagnetic radiation fields into the numerical simulation of plasmas are examined to clarify their close relations to each other and to explain their relative rates of generation of unwanted radiation field noise. (auth)

32527 MAGNETOHYDRODYNAMIC TURBULENCE EXPERIMENTS IN A TRANSVERSE MAGNETIC FIELD. Kellam, John M. (Johns Hopkins Univ., Baltimore). Phys. Fluids; 15: No. 6, 1038-46(Jun 1972).

Random fluctuations in a transverse magnetic field caused by a helium plasma produced in an arc discharge were measured with magnetic probes. Ensemble averaged power spectra of these fluctuations followed a power law over the frequency range from about 0.2 to 1 MHz, the exponents varying from $-^{11}/_{3}$ to $-^{19}/_{3}$. The time average of the fluctuation intensity parallel to the external magnetic field increased nearly linearly with the imposed field up to about 1000 G. Stronger magnetic fields inhibited these fluctuations and retarded the flow of the plasma. Integral and microscales were in the range of 40 to 100 mm and 20 to 40 mm, respectively. The random fluctuations in the magnetic field may have been due partly to random inhomogeneities in the conductivity of the plasma and only partly to vortical turbulence. Magnetic and conductivity probes indicated the presence of substantial electrical conductivity ahead of the luminous plasma. This conductivity was reduced by increasing magnetic field, interpreted as involving an electron flux. (auth)

32528 OPTICAL MEASUREMENTS OF THE DEGREE OF TURBULENCE OF A GUN PLASMA. Matt, D. R.; Scott, F. R. (Univ. of Tennessee, Knoxville). Phys. Fluids; 15: No. 6, 1047-50(Jun 1972).

Turbulent electric fields of the order of 7 kV/cm were observed in a plasma from a gun. These values were obtained by measuring the ratio of the forbidden companions of the He I 4471 and He I 4921-Å lines to their corresponding allowed transitions. The electric fields were also observed by examining the shape of the red wing of the He I 4471-Å and the He II 4686-Å lines. The measured plasma charge density of $7 \times 10^{12}/cm^3$ was too low to account for the broadening. The plasma turbulence was determined to be 3% of the electron thermal energy. The observed damping was compatible with spatial linear Landau damping for a mean wavelength 30 times the Debye wavelength. (auth)

32529 CONDUCTIVITY OF AN ANISOTHERMAL MAGNETOPLASMA FROM A CONVERGENT KINETIC EQUATION. Lai, Hon-ming (Darthmouth Coll., Hanover, N. H.). Phys. Fluids; 15: No. 6, 1051-5(Jun 1972).

The convergent classical kinetic equation of Kihara and Aono is used to calculate the collisional part of the ac electrical conductivity of a multispecies, anisothermal magnetoplasma in the long-wavelength limit. A two-component plasma result is derived, and it shows that at $T_e/T_i \gtrsim 10^3$, the Coulomb logarithmic term is no longer dominant. (auth)

32530 CONDUCTIVITY OF A MAGNETOPLASMA FROM A QUANTUM MECHANICAL CONVERGENT KINETIC EQUATION. Pytee, Agnar; Lai, Hon-ming (Darthmouth Coll., Hanover, N. H.). Phys. Fluids; 15: No. 6, 1056-8(Jun 1972).

The quantum-mechanical version of Baldwin's convergent kinetic equation is used to calculate the collisional part of the ac electrical conductivity tensor of a multispecies magnetoplasma to second order in the wave vector. Both dominant (Coulomb logarithm) and subdominant terms are calculated exactly to first order in the plasma parameter. Full account is taken of the heavy ion motion. (auth)

32531 MICROSCOPIC THEORY OF CONDUCTIVITY OF A WEAKLY IONIZED PLASMA. Chappell, W. R. (Univ. of Colorado, Boulder); Williams, R. H. Phys. Fluids; 15: No. 6, 1059-62(Jun 1972).

Through the use of the microscopic density functions in μ space, the conductivity for a weakly ionized plasma can be expressed in terms of a function describing single particle diffusion in the plasma. This diffusion function or transition probability was shown to obey a linear Boltzmann equation. As a result, the approximate solution of the conductivity problem can be accomplished either by modeling the collision term in the kinetic equation or by a stochastic modeling of the diffusion function itself. The two approaches are seen to be completely equivalent. (auth)

32532 LAMINAR INTERACTIONS OF COUNTERSTREAMING MAGNETIZED PLASMAS. Widner, Melvin M.; Wright, Thomas P. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev. Lett.; 28: No. 18, 1179-82(1 May 1972).

Laminar interactions of plasmas of different mass and density, streaming transverse to a magnetic field, are described theoretically and by computer simulation. Piston–ion dynamics yield new solutions not found in single fluid problems. (auth)

32533 PARTIAL THERMODYNAMIC EQUILIBRIA IN PLASMA. Richter, J. (Univ., Kiel). pp 37-58 of Phenomena in Ionized Gases, 1971. /Davenport, P. A. (ed.). Oxford; Donald Parsons and Co. Ltd. (1971).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

Two groups of plasma models are discussed. The first group, known as corona models, can be applied if the plasma is far from thermodynamic equilibrium and only a few microscopic processes determine excitation and ionization, whereas the second group, known as equilibrium models, may be applicable if the plasma is close to equilibrium or a large number of microscopic processes occur. A model belonging to the second group represented partial local thermodynamic equilibrium (PLTE). After a short discussion of thermodynamic equilibrium (TE relationships) model calculations and experiments are discussed. Nearly all calculations are concerned with hydrogen, hydrogen-like or hydrogenic systems, whereas a lot of the experimental work is concerned with Ar, and especially Ar arcs. Cross sections with a tolerable accuracy are known only for these systems, and Ar arcs are stable plasma sources, easy to operate. Ar and H have the common property that the energy of the first excited level is close to the ionization energy. The model, however, can easily be extended to more complicated atomic systems. Amongst matters discussed are: rate equations and LTE criteria: homogeneous and optically thin models; absorption processes; influence of diffusion; and electron and gas temperatures. (65 references) (UK)

32534 NON-IDEAL PLASMAS. Krasnikov, Y. G. (Lebedev Inst. of Physics, Moscow); Kulik, P. P.; Norman, G. E. pp 405-35 of Phenomena in Ionized Gases, 1971. /Davenport, P. A. (ed.). Oxford; Donald Parsons and Co. Ltd. (1971).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

A nonideal plasma is defined as one in which the mean interaction energy of the particles is of the same order as their kinetic energy. Plasma nonideality is related to temperature and density, and may be due to charge–charge, charge–neutral and neutral–neutral interactions. At extremely high densities, plasmas may behave similarly to liquid metals. The main theoretical and experimental results recently obtained concerning thermodynamical, transport, and optical properties of dense nonideal plasmas are reviewed under the following headings: weakly nonideal plasmas; thermodynamical inequalities and quantum effects; application of Monte Carlo method; similarity relations; gas models; metallic models; and experimental investigations. (52 references) (UK)

32535 FORMATION OF A PLASMA SHEATH WITH SECONDARY ELECTRON EMISSION. Anderson, N. (Univ. of York, Eng.). Int. J. Electron.; 32: No. 4, 425-33(Apr 1972).

A simple model construction for the formation of a plasma sheath takes into account in a simple way the emission of secondary electrons from the surface of the wall bounding the plasma. (auth)

32536 POPULATION DENSITY AND LTE OF EXCITED ATOMS IN POSITIVE-COLUMN PLASMA. I. CALCULATION ON HYDROGEN. Fujimoto, Takashi; Ogata, Yoshiro; Sugiyama, Ikuto; Tachibana, Kunihide; Fukuda, Kuniya (Kyoto Univ.). Jap. J. Appl. Phys.; 11: No. 5, 718-25(May 1972).

Collisional–radiative model is applied to hydrogen plasma in a positive column and it is shown that as electron density increases in plasma, population density of an excited level goes, in general, along coronal and quasi- and full-saturation phases and finally reaches LTE. Atomic processes responsible for these phases are examined so that a criterion is presented for each transition between the successive phases. Further, it is proved that the validity condition for LTE proposed by Griem corresponds to the transition from the coronal to the quasi-saturation phase in a positive-column plasma. (auth)

Production

Refer also to abstract 32520.

32537 BOUNDED MAGNETOPLASMAS: PRODUCTION AND DIAGNOSTICS AT HIGH FREQUENCIES. Mendelovicz, Ephraim. Syracuse, N. Y.; Syracuse Univ. (1971). 94p. University Microfilms Order No. 72-12,927.

Thesis.

Production and diagnosis of a bounded magnetoplasma by application of microwaves are dealt with. Wave phenomena in plasmas with dimensions of the order of magnitude of a free-space wavelength and large compared to the Debye length are considered. Two special cases of such bounded plasmas are considered; these are magnetoplasmas in a microwave cavity and in a parallel infinite-plane resonator. A plausible criterion for whistler plane-wave analysis in finite transverse geometries is proposed, and it is used to find the optimal conditions, in the sense of least plasma frequency and smallest transverse dimension, under which laboratory whistler experiments can be performed. The results are applied to evaluate some experiments reported in the literature. The problem of diagnosing a uniform magnetoplasma in a cylindrical cavity is attacked by using an available exact theory to compute curves of resonant frequencies versus plasma density for modes of interest. Such curves were obtained for different cavity aspect ratios to learn the limiting behavior when the lateral dimensions become large. Field distributions were computed using the exact theory and were used to evaluate the diagnostic qualities of the modes in question. The particular scheme of plasma production with the TE$_{011}$ mode is considered. Curves are obtained for magnetic tuning, i.e., resonating the plasma-filled cavity at fixed driving frequency by varying the magnetic field when the plasma density changes. Some field distributions are given in order to deal with the coupling to the plasma-filled cavity. In particular, a double-tuned cavity system, designed to preserve power feed and cavity azimuthal symmetry, is discussed at some length. Results are used to outline some possible experiments. (Diss. Abstr. Int., B)

32538 ONSET POINT OF IONIZATION. Murty, S. S. R. (Indian Inst. of Science, Bangalore); Serou, P. Phys. Fluids; 15: No. 6, 1035-7(Jun 1972).

It is shown that precursor photoionization is capable of creating electron number densities large enough to virtually eliminate the atom–atom collision region and the Mach number at which the above phenomenon occurs is calculated for a few initial pressures and temperatures for argon. (auth)

32539 PRODUCTION OF RELATIVISTIC PLASMA BY ADIABATIC COMPRESSION IN A PLASMA–BEAM SYSTEM. Zakatov, L. P.; Ivanov, A. A.; Plakhov, A. G.; Shapkin, V. V. JETP Lett. (USSR) (Engl. Transl.); 15: No. 1, 10-13(5 Jan 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 1, 16-20(5 Jan 1972).

The possibility of obtaining a relativistic dense plasma by adiabatic compression of the high-energy component of a plasma produced in a beam–plasma system is considered. The effects of adiabatic compression on plasma parameters, with allowance for relativistic factors, are studied. By starting from the transverse adiabatic invariant and from the expression for the total energy, one can obtain the increase of the kinetic energy of the electron when the magnetic field intensity is changed a small factor. (M.O.W.)

32540 IONISATION IN COMBUSTION REACTIONS. Sugden, T. M. (Thornton Research Center, Chester, Eng.). pp 437-61 of Phenomena in Ionized Gases, 1971. /Davenport, P. A. (ed.). Oxford; Donald Parsons and Co. Ltd. (1971).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

It is known that some flames are either inherently good conductors of electricity or can be made so by small amounts of certain additives, particularly metals, and advances recently made in the understanding of the process or ionization responsible for the conductivity are reviewed. It is stated that the special features that make flame ionization of interest in the field of ionized gases are that the primary source of ionization is chemical reaction amongst neutral species, and that the ions concerned are often unusual and difficult to produce and study under conditions other than in flames. The review is presented under the following headings: outline of flame chemistry; experimental methods of flame ionization (high-frequency and microwave methods; probe methods; mass-spectrometric methods; optical methods); additive ionization in flames (alkali elements in Ga, In, Tl, alkali elements with halogens, and alkaline earths); transferred additive ionization; and natural ionization in hydrocarbon flames. (18 references) (UK)

32541 ION TEMPERATURE OF LASER-PRODUCED PLASMA. Kang, Hyung-boo; Yamanaka, Tatsuhiko; Yoshida, Kunio; Waki, Motoichiro; Yamanaka, Chiyoe (Nagoya Univ., Japan. Osaka Univ.). Jap. J. Appl. Phys.; 11: No. 5, 765-6(May 1972).

Ion temperatures of laser-produced plasma were estimated from ion velocity distributions measured by a time-of-flight experiment. The experimental technique is briefly described. Diagrams of the ion velocity distribution are shown. (M.O.W.)

Stability

Refer also to abstracts 31900 and 32564.

32542 (AD–734692) CROSS-FIELD CURRENT-DRIVEN ION ACOUSTIC INSTABILITY. Barrett, P. J.; Fried, B. D.; Kennel, C. F.; Sellen, J. M.; Taylor, R. J. (California Univ., Los Angeles. Plasma Physics Group). Dec 1971. Contract N00014-69-A-4023. 14p. (PPG–94). NTIS.

The report discusses the instability that occurs when electrons and ions have a relative streaming velocity, along x, $V_D > c_s = \sqrt{T_e/m}$, across a weak magnetic field, B_z. If $k_x r_c$ Mach >1 and $\omega \ll \omega_{ce}$, the spatial growth rate is enhanced by a factor K_x/K_z over the value at $B_z = 0$. Measurements of growth rate (Im k/Re k) were carried out in two different plasma configurations as a function of both B_z and ω. The results are consistent with the linear dispersion relation for this instability. (auth) (NTIS)

32543 (COO–1478-10) MICROINSTABILITIES IN INHOMOGENEOUS PLASMA. Progress Report, May 1, 1971–January 31, 1972. Kammash, Terry (Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering). Jan 1972. Contract AT(11-1)-1478. 9p. Dep. NTIS.

Most of the research effort this period was devoted to the following two areas: (1) beam–plasma interactions and instabilities in astron, and (2) absolute instabilities with arbitrary propagation in mirror plasmas. A brief discussion of important results in these two areas is given. (M.O.W.)

32544 (NP–19260) THEORY OF HYDRODYNAMIC STABILITY OF PLASMA IN THE FIELD OF AN ALFVEN WAVE OF FINITE AMPLITUDE. Elfimov, A. G.; Nekrasov, F. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Sukhumi. Fiziko-Tekhnicheskii Institut). 1971. 27p. (In Russian). Dep. NTIS (U. S. Sales Only).

The stability of a plasma located in the field of a self-consistent Alfvén wave is investigated, and the decay instability for a plasma was $\beta \gg 1$ is examined. The increments and zone width of instability and the critical wave amplitude are found. The problem is solved for both stationary and moving Alfvén waves, and a difference is revealed between decay instability and parametric instability in a homogeneous high-frequency field. An instability associated with Alfvén-wave scattering is found, conditions for excitation of which are less rigorous than conditions for excitation of decay instability. (tr-auth)

32545 (NP–19268) PARAMETRIC INSTABILITIES OF A TOROIDAL HIGH-FREQUENCY DISCHARGE IN A MAGNETIC FIELD. Roife, I. M.; Vasilevskii, M. A.; Seredenko, E. V. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

Experimental results of the rf discharge in a toroidal chamber in a magnetic field are reported. The discovered MHD instability has the character of a parametric instability for rf currents in a longitudinal magnetic field. The experimental results are MHD compared to calculations carried out for an ideal MHD model. (auth)

32546 DYNAMIC STABILIZATION OF THE HELICAL m = 1 INSTABILITY IN A LINEAR SCREW PINCH. Gruber, Otto (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys.; 251: No. 4, 333-53(1972).

Dynamic stabilization of the helical m = 1 instability was studied in the linear high-β screw pinch ISAR III ($T_i \approx 50$ to 500 eV; $n_e \approx 5 \times 10^{16}$ cm^{-3}; $\beta \geqq 0.5$). The experimentally determined growth rates ω_1(0.5 to 3×10^6 s^{-1}) and wavelengths (100 to 200 cm) of these modes are about the same as in a toroidal screw pinch and both agree well with theory. Two methods of dynamic stabilization were investigated. In both cases the stabilizing effects were better than expected from existing theory. In the first method an axially uniform oscillating field $\tilde{B}_{z0} \times \sin(\omega_s t)$ was superposed on the quasi-steady B_{z0} filed ($\omega_s > \omega_1$). The m = 1 mode is stabilized and a stabilization condition $\tilde{B}_{z0}/B_{z0} \gtrsim 2\omega_1/\omega_s$ holds. This stabilizing effect is very likely caused by inertial forces produced by enforced m = 0, k = 0 oscillations of the plasma column. When working in resonance with the natural plasma oscillations, it is easier to satisfy the above condition. In the second method oscillating currents $\tilde{I}_{z0} \times \sin(\omega_s t)$ were added to the axial plasma current I_{z0} to study the stabilization by dynamic shear ($\omega_s > \omega_1$). Magnetic probe measurements showed that the $\tilde{I}_z$ flows in the dilute plasma outside the dense plasma column. The measured skin depths and resistivities are larger than those expected from classical theory. Nevertheless, a reduction of the growth of the m = 1 mode occurred which was larger the more closely $\tilde{I}_z$ flowed alongside the plasma column, giving a stabilization condition $\tilde{I}_{z0}/I_{z0} > \omega_s/(5\omega_1)$. (auth)

32547 ENERGY DISTRIBUTION FUNCTION IN COUNTER BEAM INSTABILITY. Yatsu, K.; Hagiwara, S.; Kojima, S. (Tokyo Univ.). Phys. Lett.; 39A: No. 2, 81-2(24 Apr 1972).

A study was made of the energy distribution function related to the instability in counter electron beams with different velocities. Two or more peaks were observed in the distribution function when the oscillation set up standing waves in the system. (auth)

32548 ION-ENHANCED DIFFUSION IN QUASI-STABLE DRIFT WAVES. Ching, Hugh (New York Univ., N. Y.). Phys. Fluids; 15: No. 6, 1151-3(Jun 1972).

An improved quasi-linear theory of drift waves is shown to be capable of accounting for the existence of finite, ion-enhanced diffusion even when the waves are stable and collisions are absent. (auth)

32549 FINITE BETA STABILIZATION OF THE DRIFT-CONE INSTABILITY. Tang, W. M.; Pearlstein, L. D.; Berk, H. L. (Univ. of California, Livermore). Phys. Fluids; 15: No. 6, 1153-5(Jun 1972).

An analytic expression giving the drift-cone stability criterion of a finite-beta plasma is derived using a mirror-ratio-dependent loss-cone ion distribution. This is used to determine a beta limit for stability which is found to be insensitive to changes in mirror ratio and plasma temperature. (auth)

32550 INSTABILITY OF MAGNETOSONIC WAVES IN A REACTING THERMONUCLEAR PLASMA. Tidman, D. A. (Versar Inc., Springfield, Va.). Phys. Fluids; 15: No. 6, 1155-7(Jun 1972).

The instability of magnetosonic waves in a reacting thermonuclear plasma is discussed, and their growth rate is calculated. (auth)

32551 GROWTH RATES OF INSTABILITIES OF A DIFFUSE LINEAR PINCH. Goedbloed, J. P. (FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands); Hagebeuk, H. J. L. Phys. Fluids; 15: No. 6, 1090-1101(Jun 1972).

In order to obtain growth rates of magnetohydrodynamic instabilities, the equation of motion of a diffuse linear pinch is solved analytically in the tokomak approximation and numerically without approximation. The growth rates of kinks are calculated for the Lundquist field. The constant-pitch magnetic field is shown to be unstable to quasi kinks, quasi interchanges, and pure interchanges that dominate, respectively, at increasing values of the negative pressure gradient. Analytical expressions and numerical values for the growth rates of these modes are given. Interchanges in a sheared magnetic field are investigated numerically and checked by means of perturbation theory. (auth)

32552 VLASOV FLUID MODEL FOR STUDYING GROSS STABILITY OF HIGH-β PLASMAS. Freidberg, J. P. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids; 15: No. 6, 1102-8(Jun 1972).

A model is presented which provides a more realistic description of the gross stability properties in high-β plasmas than that given by ideal magnetohydrodynamics. (auth)

32553 MEASUREMENTS OF THE SELF-STABILIZATION OF A TWO-ION-BEAM INSTABILITY. Baker, D. R. (European Space Research Inst., Frascati, Italy). Phys. Rev. Lett.; 28: No. 18, 1189-92(1 May 1972).

The self-stabilization of the two-ion-beam instability due to microturbulent ion heating was measured in a plasma with variable temperature ratio ($2.0 < T_e/T_i < 10.0$). When the plasma is unstable, excited ion waves and background microturbulence are observed to grow, saturate, and damp, in conjunction with ion heating. When the plasma is stable, no ion heating is observed. The ion heating e-folding length is $\approx 500\lambda_{de}$. This heating may occur in the formation of collisionless shocks. (auth)

32554 INSTABILITIES OF EXTRAORDINARY WAVE IN A COLLISION-DOMINATED PLASMA. Shimomura, Noboru (Osaka Kyoiku Univ.). J. Phys. Soc. Jap.; 32: No. 5, 1359-67(May 1972).

The instabilities of the extraordinary wave are studied by taking into account the effect of finite wave number. It is assumed that the unperturbed velocity distribution of electrons is a spherical shell in velocity space and the electron's collision frequency ν with neutral particles depends on the magnitude of their velocities v_0, namely, $\nu \propto v_0^h$. The dispersion relation is obtained for the case in which the refractive index is much larger than unity. The dispersion curves of the wave for $h \neq 0$ show that the occurrence of instabilities may be expected at both sides near the cyclotron frequency and the higher harmonics. The conditions for onset of the collision-induced instability at the cyclotron frequency and the second harmonic are given by $h > 3$ and $h > 5$ respectively in the long-wavelength limit. When the wave number and the electron density are chosen suitably, the conditions are modified as $h > 2.6$ and $h > 3.7$. (auth)

32555 STABILITY OF REVERSE-FIELD DIFFUSE PINCH. Amano, Tsuneo (Osaka Univ.); Tamai, Tadamoto; Wakatani, Masahiro. J. Phys. Soc. Jap.; 32: No. 5, 1385-93(May 1972).

The stability of reverse-field diffuse pinch against the hydromagnetic and resistive instabilities is investigated. By means of Newcomb's criterion, the hydromagnetic stability is tested for a number of model-field configurations which are obtained by a modification of the force-free fields. Stability diagrams showing the position of the conducting wall for stability are computed by changing the shape of the axial current distribution, the average beta, and the degree of the field reversal. The growth rates of the hydromagnetic instability for some unstable configurations are also computed. The stability against the tearing and resistive slow interchange modes is examined following the method due to Coppi, Green, and Johnson. It is shown that the reverse-field configuration is vulnerable to the tearing instability when the pressure profile is nearly uniform in the central region of the plasma. (auth)

32556 TOKAMAK WITH NONROUND SECTION OF THE PLASMA LOOP. Artsimovich, L. A.; Shafranov, V. D. JETP Lett. (USSR) (Engl. Transl.); 15: No. 1, 51-4(5 Jan 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 1, 72-6(5 Jan 1972).

The effects of configuration changes in the plasma loop are studied. For the case of elongation of the loop cross section, electron temperature, instabilities, and thermal properties are discussed. (M.O.W.)

Thermonuclear Processes

32557 (CONF-710624) PROCEEDINGS OF THE INTERNATIONAL WORKING SESSIONS ON FUSION REACTOR TECHNOLOGY, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TENNESSEE, JUNE 28–JULY 2, 1971. Steiner, Don (ed.) (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. 402p. Dep. NTIS.

The conference contained 8 sessions. A state-of-the-art presentation and session summary are given for the following areas: (1) engineering design of blankets, (2) plasma heating and ignition, (3) neutronics, (4) surface phenomena, (5) radiation damage, (6) plasma fueling and recovery, (7) engineering design of magnet systems, and (8) energy conversion systems. (M.O.W.)

32558 (CONF-720401–3) REQUIREMENTS TO BE MET FOR AN ECONOMICALLY ATTRACTIVE EXPLODING PELLET FUSION REACTOR. Fraas, A. P. (Oak Ridge National Lab., Tenn.). Apr 1972. 16p. Dep. NTIS.

From Region III conference on scanning the spectrum; Knoxville, Tenn. (10 Apr 1972).

The discussion considers such topics as energy balance, blast containment and fuel costs. In particular, boundary conditions that must be met if this type of system is to be economically feasible are discussed. (M.O.W.)

32559 (CONF-720412–1) ENGINEERING OF THERMONUCLEAR POWER PLANTS. Fraas, A. P. (Oak Ridge National Lab., Tenn.). 5 Apr 1972. 19p. Dep. NTIS.

From American Society of Electrical Engineers conference; Knoxville, TN. (5 Apr 1972).

A typical conceptual design of a complete fusion reactor is described. The blanket and shielding materials are discussed for the deuterium–tritium fuel cycle. Time and cost estimates are also given, along with a radiation hazards analysis. (M.O.W.)

32560 (IPP–6/100) INVARIANT CURVES OF PLANE MAPPINGS. von Finckenstein, Karl Graf Finck; von Hagenow, Karl-Ulrich; Schlueter, Arnulf (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Nov 1971. 26p. (In German). Dep. NTIS (U. S. Sales Only).

A special problem relating to the existence of magnetic surfaces near the axis of a toroidal magnetic field is dealt with: given a plane mapping T with a fixed point p; what are the conditions under which T has invariant curves around p? First, the cases where the curves concerned are ellipses or hyperbolae are discussed. Here, all continuous mappings that keep such curves invariant can be characterized. A few more general investigations are then made and, finally, examples are studied. (auth)

32561 (ORNL-TM–3783) PROSPECTS FOR ALTERNATE FUSION FUEL CYCLES AT ULTRA-HIGH TEMPERATURES. McNally, J. Rand Jr. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 20p. Dep. NTIS.

Recent experiments and theory give support to the idea of developing a closed magnetic mirror by the self-field of a trapped ring current. Since the mirror reactor may be able to operate at much higher burning temperatures than toroidal reactors, the viability of charged-particle fusion chain reactions is thereby increased and may permit the chain reaction burning of cheap Li or Be nuclear fuel. Reaction kinetics studies in partially closed mirrors show MeV energies for the light fusion reaction products which can act as catalysts or chain centers for the propagation of such reactions. The MeV particles may also permit sustainment of both the ring-current configuration and the burning temperature. Numerous problem areas associated with this approach are tabulated and will require extensive research. (auth)

32562 (TRITA-EPP-71-15) SOME TECHNOLOGICAL PROBLEMS OF THE COIL SYSTEM OF INTERNAL RING DEVICES. Lehnert, B. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). 16 Jul 1970. 29p. Dep. NTIS (U. S. Sales Only).

A number of technological problems of the coil system of internal ring devices with magnetically shielded supports are discussed under thermonuclear reactor conditions: (i) The Ohmic power losses of the internal ring system can be made much smaller than the thermonuclear reaction power, even with copper windings at room temperature. This is not only the case for the DT reaction, but it even becomes possible for the DD reaction at powers of about 10^{10} W and radial dimensions of the order of 10 m. The physical reason for this result is that only a fraction of the total field energy of the system originates from the internal coil under optimum conditions. (ii) The supports can be made large enough to provide cooling ducts for the internal ring system. (iii) The mechanical stresses on the system can be kept within technically feasible limits. (auth) (Sweden)

32563 MAGNETIC GUARDING OF OCTUPOLE HOOP SUPPORTS. Molvik, Arthur W. (Univ. of Wisconsin, Madison). Phys. Fluids; 15: No. 6, 1128-33(Jun 1972).

Magnetic guarding of hoop supports and other obstacles in the Wisconsin octupole reduced the direct loss of plasma to the supports or obstacles by more than an order of magnitude. However, an increased loss rate to the walls and hoops locally around a support offset the reduction in direct loss. Theoretical models based on ion scattering or collective effects were consistent with the magnitude of the increased wall (hoop) loss rate with guarding. But, only the models based on collective effects or associated with the lack of symmetry between each support and the octupole magnetic field were reasonably consistent with the observed scaling of the loss rate with ion temperature and magnetic field. (auth)

Wave Phenomena

32564 (AD-734782) TRAPPED-PARTICLE PHENOMENA AND NONLINEAR INTERACTION BETWEEN ELECTROMAGNETIC WAVES AND PLASMAS. Final Report. Wong, Alfred Y. (California Univ., Los Angeles. Dept. of Physics). Dec 1971. 3p. (AFOSR-TR-72-37). NTIS.

Trapped-particle phenomena are clarified by a time-resolution technique. It was found that oscillatory structures cannot always be attributed to trapped particles; interaction between bursts and waves could give rise to a similar interference pattern. Techniques demonstrate the propagation of electron waves directly and do not require any lock-in detection techniques, which tend to mask the contribution of electron bursts; in addition, new nonlinear states of electron waves are found. Greater understanding of plasma heating by electromagnetic waves was gained. It was found that plasma heating at the cutoff location is possible and desirable, since no accessibility problem arises. The laboratory demonstration of this effect relates directly to the ionospheric modification experiments. The laboratory experiment is very helpful to fusion researchers since they can now use lasers to heat plasmas at cutoffs instead of resonance. (auth) (NTIS)

32565 (EUR-CEA-FC-627) WAVE CONVERSION IN AN INHOMOGENEOUS PLASMA. Agnello, V.; Fieffe-Prevot, P.; Ichtchenko, G.; Kulinski, S. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec 1971. 23p. Dep. NTIS (U. S. Sales Only).

An analysis is made to find the reflection, transmission, and absorption coefficients for a plane wave incident obliquely on an inhomogeneous anisotropic plasma layer. The differential equations for this case are derived from Maxwell's equations together with the constitutive relations for the medium. (M.O.W.)

32566 ABSORPTION OF ELECTROMAGNETIC WAVES IN A LINEAR LAYER IN PLASMA RESONANCE REGION. Omel'chenko, A. Ya.; Panchenko, V. I.; Stepanov, K. N. Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 10, 1484-7(1971). (In Russian).

Results are given of numerical calculations of the absorption coefficient of an electromagnetic wave polarized in the incidence plane at oblique incidence on the linear plasma layer when the absorption is due to the field-broadening effect in the plasma resonance region. (auth)

32567 PROPERTIES OF ION VIRTUAL WAVE. Takamura, S.; Okuda, T. (Nagoya Univ., Japan). Phys. Lett.; 39A: No. 2, 91-2(24 Apr 1972).

The virtual wave produced nonlinearly by the two propagating ion waves is observed experimentally. (auth)

32568 ENHANCED DAMPING OF ELECTROSTATIC WAVES DUE TO COMBINATION SCATTERING FROM DENSITY OSCILLATION IN PLASMAS. Ohkubo, K.; Tanaka, S. (Kyoto Univ.). Phys. Lett.; 39A: No. 2, 115-16(24 Apr 1972).

Experiments demonstrating the combination scattering of the electrostatic wave from the electron density oscillation in plasmas are described. The spatially periodic energy transfer among the satellite modes and the primary mode, which results in an enhanced damping of the primary model, is observed. (auth)

32569 EXPERIMENTAL TEST OF QUASI-LINEAR THEORY. Roberson, Charles Wayne. Austin, Tex.; Univ. of Texas (1971). 79p. University Microfilms Order No. 72-11,413.

Thesis.

The nonlinear evolution of the instability resulting from a "gentle bump" on the tail of the electron velocity distribution of a plasma was investigated experimentally. The experiment was designed as a test of the quasi-linear theory of electron plasma waves. An electron beam with a large velocity spread was injected along the axis of a collisionless plasma column immersed in a strong magnetic field. The equilibrium wave amplitude, spectral shape, and electron velocity distribution were measured and found to be in good agreement with the predictions of quasi-linear theory. (Diss. Abstr. Int., B)

32570 PARAMETRIC COEXCITATION OF ION-ACOUSTIC WAVES AND ELECTRON PLASMA WAVES BY A HIGH-FREQUENCY ELECTRIC FIELD. Stowe, David William. Urbana, Ill.; Univ. of Illinois (1971). 97p. University Microfilms Order No. 72-12,400.

Thesis.

The basic theory of parametric coexcitation of ion-acoustic and electron plasma waves by a high-frequency electric field is reviewed. Numerical calculations show that plasma–neutral collisions and steady-state drift velocities have a significant influence on the interaction. Parametric excitation of ion-acoustic waves is observed experimentally in a helium dc discharge. The observations indicate that the radial density profile of the dc discharge modifies the parametric effect. In the absence of an applied field, unstable electron drift-excited ion-acoustic waves are experimentally observed. These waves are found to satisfy the dispersion relation for a plasma consisting of He^+ and He_2^+. (Diss. Abstr. Int., B)

32571 COLLISIONAL EFFECTS ON SPATIAL ION WAVE ECHOES IN A PLASMA. Sasaki, A.; Sato, N. (Tohoku Univ., Sendai). Phys. Fluids; 15: No. 6, 1157-9(Jun 1972).

Effects of ion–ion collisions on ion wave echoes are studied experimentally in a Q-machine plasma. The spatial damping of the echo peak amplitude is observed to be different from earlier measurements. (auth)

32572 TURBULENCE FOLLOWING ION-ACOUSTIC SHOCKS. Mason, R. J. (Bell Telephone Labs., Inc., Whippany, N. J.). Phys. Fluids; 15: No. 6, 1162-4(Jun 1972).

Extended particle-in-cell investigations of ion-acoustic shocks with isothermal electrons verify predictions of a maximal shock Mach number slightly above 1.5 and demonstrate the presence of post-frontal turbulence that intensifies with both the Mach number and initial electron-to-ion temperature ratio. (auth)

32573 DEPOLARIZATION OF SINGLY SCATTERED RADIATION IN A TURBULENT PLASMA. Halseth, M. W. (Massachusetts Inst. of Tech., Lexington); Sivaprasad, K. Phys. Fluids; 15: No. 6, 1164-6(Jun 1972).

Single scattering in a weakly inhomogeneous turbulent plasma is examined for angles of incidence greater than the critical angle of the medium. A possible mode for depolarization of backscattered radiation is discussed with the help of the radiative transport equation. (auth)

32574 MODE COUPLING IN ION ACOUSTIC WAVES AND NONLINEAR WAVE PARTICLE INTERACTION IN LANGMUIR WAVES. Martin de Julian, Pablo. Los Angeles; Univ. of California (1971). 209p. University Microfilms Order No. 72-11,892.

Thesis.

Collisionless mode coupling and wave–particle interactions in electrostatic waves are studied. Mode coupling was solved by a perturbation analysis in x–t space, followed by an iteration procedure. Wave–particle interactions are treated on the same basis as a wave amplitude. The analysis is done up to second order in wave amplitude, and it can be applied to one or several monochromatic waves. Computations are carried out for the spatial interaction of three and five ion acoustic waves using fluid equations first and collisionless kinetic theory later. Two waves are steadily driven in the plasma at the same point, and all the other waves appear as a consequence of mode coupling. Explosive instability appears in both analyses (fluid equations and Vlasov equations) when the waves are unstable. The wave–particle interaction modifies these results, and the waves first saturate and then tend to zero. The initial wave with the largest frequency saturates first. Free-streaming terms are also included in later analyses. A new form for the free-streaming terms in the linear theory is found for boundary-value problem (k real, ω complex) and steady-state (k complex, ω real). The new form has the advantage that the integrals over velocity can be computed by the residue method, since the integral along the lower (or upper) semicircle at infinity is zero. Evolution of the linear Landau damping (γ) or growth is analyzed by a second procedure, where the quasi-linear equation is used for obtaining a differential equation for γ, after neglecting all the terms of order higher than $\gamma_0\gamma/\Omega^2$ (γ is the initial Landau damping and Ω is the real frequency). The differential equation can be solved exactly. The approximations done are more justified for damped waves than for unstable waves. For damped waves the solution predicts the two regions that one can physically expect: (1) the case of small amplitude where the wave is damped to zero, and (2) the case of large-amplitude waves where the damping becomes zero and the wave reaches a nonzero stationary amplitude. The results are less accurate for large amplitude than those obtained by other authors, but more general because they can be applied to small and large-amplitude waves and also for nonMaxwellian distribution functions. (Diss. Abstr. Int., B)

32575 NEAR-STEADY OBLIQUE SHOCK WAVES IN A COLLISIONLESS PLASMA. Olson, Lynn M. (Univ. of Wisconsin, Madison). Phys. Fluids; 15: No. 6, 1070-81(Jun 1972).

Waves of small amplitude ϵ which travel at an oblique angle θ to a magnetic field in a cold collisionless plasma and whose head approaches steadiness are studied. The relevant double limit $\lim_{\epsilon\to 0}\lim_{t\to\infty}$ is treated in terms of appropriate sets of single limits. Near-steady waves which can lead from one equilibrium to another are shown to be possible only at propagation speeds corresponding to Alfvén Mach number 1 or cos θ. In the first case, either the magnetic pressure at the head of the wave decreases monotonically from its initial value and the wave spreads linearly with time, or else the head of the wave consists of a near-periodic train of cnoidal waves, the first crest of which approaches a soliton. For near-normal shocks, the magnetic pressure in the near-periodic wave train always exceeds its initial equilibrium value. But for $M \cot \theta > 1$, where $M = (m_+/m_-)^{1/4} - (m_-/m_+)^{1/4}$, it always falls short of that value. A transition with precursor wave is shown to be impossible for a cold collisionless plasma. At an Alfvén Mach number cos θ, the only near-steady solution consists of a main wave front followed by an oscillatory tail; on the length scale considered, the electric field transverse to the propagation direction oscillates without bound at the tail. (auth)

32576 ION AND ELECTRON PRESSURE EFFECTS ON MAGNETOSONIC SHOCK FORMATION. Mason, R. J. (Bell Telephone Labs., Inc., Whippany, N. J.). Phys. Fluids; 15: No. 6, 1082-9(Jun 1972).

Piston generated magnetosonic shocks were investigated with a hybrid particle-in-cell simulation scheme that retains electron inertial effects and pressure but neglects resistivity. At low piston Mach numbers, $M_p \leq 1.0$, the c/ω_{pe} scale wave-train shocks of Auer, Hurwitz, and Kilb are reproduced. For M_p = 1.7 post-frontally flat shocks with strong precursors are obtained. For $M_p \geq 2.4$ pure piston reflected flow is observed. All these flows are predominantly laminar. Electron pressure effects are found to scale as $(1 + \beta_{e0})/M_p^2$, $B_{e0} = P_{e0}/(B_0^2/8\pi)$. Finite ion pressure smooths the post-frontal flow through ion Landau damping. Comparisons are made with results from other recent simulations, and with observations from laboratory experiments at Culham and Garching. (auth)

32577 ABSORPTION OF THE ENERGY OF AN ELECTROMAGNETIC FIELD IN A RANDOMLY INHOMOGENEOUS PLASMA. Ryzhov, Yu. A. (Gorky Radiophysics Inst., USSR). Zh. Eksp. Teor. Fiz.; 62: No. 3, 924-31(Mar 1972). (In Russian).

The problem of resonance absorption of the energy of an electromagnetic field in a randomly inhomogeneous plasma is considered. In an isotropic plasma, absorption is related to excitation of plasma oscillations at points at which the dielectric permeability vanishes in a random manner. In a magnetoactive plasma, there exist surfaces on which plasma oscillations arise. Since the plasma oscillations rapidly decay, the effective losses due to excitation of plasma oscillations are equal to the heat evolved in the plasma in the resonance regions or resonance points. Expressions for the quasi-static part of the effective permeability tensor are derived for a magnetoactive plasma that are valid at resonance frequencies and permit one to correctly take into account the energy of the excited plasma oscillations. A number of examples considered illustrate the general relations. Energy losses are calculated for a one-dimensional, randomly inhomogeneous plasma in a quasi-static field, for a three-dimensional inhomogeneous plasma in the field of a metallic spheroidal dipole (self-consistent solution), and for a magnetoactive plasma in the field of a plane condenser. (auth)

32578 INTERACTION BETWEEN A LARGE AMPLITUDE DIRECT MAGNETO-ACOUSTIC WAVE OF FREQUENCY $\Omega < \sqrt{\omega_{He}\omega_{Hi}}$ AND A PLASMA. Ivanov, A. A.; Parail, V. V. (Moscow Physical-Technical Inst.). Zh. Eksp. Teor. Fiz.; 62: No. 3, 932-43(Mar 1972). (In Russian).

The interaction between a direct magneto-acoustic wave of sufficiently large amplitude and frequency $\omega_{Hi} \ll \Omega \ll \omega_{He}$ or $\omega_{Hi} \sim \Omega$ and a plasma is considered. It is shown that such waves may excite parametrically short-wave potential oscillations of frequency $\omega \sim \Omega$ in a plasma; the threshold build-up rate in this case, u (u is the electron velocity in the field of the magneto-acoustic wave) may be much less than the velocity of sound. The interaction between short-wave potential oscillations and a plasma results in efficient heating of the plasma at the expense of resonant wave absorption by the particles. The quality of such systems may be very small and not exceed 10 because of the large magnitude of the damping decrement of the potential waves. (auth)

32579 NONLINEAR DAMPING OF POTENTIAL MONOCHROMATIC WAVES IN AN INHOMOGENEOUS PLASMA. Karpman, V. I.; Shklyar, D. R. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 3, 944-56(Mar 1972). (In Russian).

Nonlinear interaction between a potential monochromatic wave and an inhomogeneous plasma is considered. The resonance particle distribution function is found for the case of weak inhomogeneity. An asymptotic expression is derived for the wave damping constant. (auth)

32580 INVESTIGATION OF PLASMA FLUCTUATIONS IN A STELLARATOR. Berezhetskii, M. S.; Grebenshchikov, S. E.; Kossyi, I. A.; Sbitnikova, I. S.; Shpigel, I. S. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 3, 957-70(Mar 1972). (In Russian).

Density and electric field oscillations of a plasma in the L-1 stellarator are investigated. The longitudinal and transverse wavelengths and oscillation frequencies are determined by the correlation analysis technique. The relation between the oscillation mode and structure and magnitude of the magnetic field strength is established. Oscillation stabilization by ion collisions is observed. It is demonstrated that the fluctuations observed are of a drift-dissipative nature and are excited by a Cherenkov mechanism and electron collisions. Other mechanisms of pumping the energy into the oscillations are discussed. (auth)

32581 HYDRODYNAMICS OF PHOTONS IN AN INHOMOGENEOUS PLASMA. Trubnikov, B. A. (Inst. of Atomic Energy, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 3, 971-9(Mar 1972). (In Russian).

Quasi-hydrodynamic equations for transverse waves in an inhomogeneous plasma are obtained in the geometric optics approximation. Examples of bounded equilibrium radiation blobs in which the light pressure is balanced by the plasma pressure are considered. The spectrum of radiation balancing a plasma of prescribed profile is calculated. (auth)

32582 STATIONARY NONLINEAR ION-ACOUSTIC OSCILLATIONS IN A DENSE WEAKLY IONIZED CURRENT-CARRYING PLASMA. Al'terkop, B. A.; Rukhadze, A. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 3, 989-94(Mar 1972). (In Russian).

The nonlinear stage of development of ion-acoustic instability of a weakly ionized current-carrying plasma is investigated under conditions of applicability of the hydrodynamic approximation. The amplitude of the stationary wave, its period and propagation velocity and also the development of instability can all be studied near the instability threshold, when only the fundamental mode increases. It is shown that growth of ion-acoustic oscillations is restricted by the ion viscosity. The case corresponding to conditions above the threshold is also studied. (auth)

32583 PARAMETRIC COUPLING OF LANGMUIR WAVES IN AN INHOMOGENEOUS PLASMA. Ikemura, Tsutomu (Kyoto Univ.); Nishikawa, Kyoji. J. Phys. Soc. Jap.; 32: No. 5, 1368-76(May 1972).

Parametric coupling of two Langmuir waves due to a combined action of a small-density gradient and an externally applied, spatially homogeneous, high-frequency electric field is investigated. It is shown that the space dependence of the pump field plays a decisive role in the parametric coupling, the space dependence being produced due to the oscillation of the electrons relative to the ions by the external field. On the basis of a fluid description of the plasma, a coupled system of partial differential equations, which describe the relevant parametric coupling, is derived to the lowest significant order with respect to the pump field. For the case where the perturbed velocity varies as $\exp [i \int^x k(x')dx']$, a nonlinear dispersion relation is obtained. (auth)

32584 TWO-DIMENSIONAL WAVE MOTION NEAR THE MAGNETIC NEUTRAL LINE. Tanaka, Masatoshi (International Centre for Theoretical Physics, Trieste, Italy). J. Phys. Soc. Jap.; 32: No. 5, 1377-9(May 1972).

The motion of a compressible, perfectly conducting fluid in the neighborhood of the magnetic neutral line of arbitrary order is examined. The equation describing the magnetic field perturbation can be reduced to a wave equation with constant coefficients when the Alfvén speed exceeds the sound speed in the fluid. Temporal development of the perturbation is calculated, together with the motion of the fluid. (auth)

32585 EXACT N-SOLITON SOLUTION OF THE KORTEWEG–DE VRIES EQUATION. Wadati, Miki; Toda, Morikazu (Kyoiku Univ., Tokyo). J. Phys. Soc. Jap.; 32: No. 5, 1403-11(May 1972).

The exact N-soliton solution of the Korteweg–de Vries equation is obtained through the procedure suggested by Gardner, Greene, Kruskal and Miura. From this solution, it is shown that solitons are stable and behave like particles. The collisions are well described by the phase shifts. Explicit calculation of the phase shifts assures the conservation of the total phase shift. This fact turns out to be a special expression for the constant motion of the center of mass. (auth)

32586 STUDY OF PERIODICALLY VARYING PLASMA MEDIUM: MODULATION OF ELECTROMAGNETIC WAVES AND MEASUREMENT OF PARAMETERS. Kumar, Satyendra; Chandra, Avinash; John, P. I.; Sarkar, D. C. (Aligarh Muslim Univ., India). Indian J. Pure Appl. Phys.; 9: No. 12, 1017-21(Dec 1971).

A plasma excited by an amplitude-modulated rf electric field possesses periodically varying parameters. It has been observed that when a microwave signal propagates through such a plasma the amplitude modulation is impressed upon the propagating signal. The percentage of modulation impressed on the electromagnetic wave passing through such a plasma is calculated by solving Maxwell's equations and the energy-balance equation. The calculated modulation percentages for various values of plasma parameters are found to be in good qualitative agreement with the available experimental results. A delayed microwave scanning technique, by which microwave pulses can be sent through the plasma at different instants relative to the rise and fall of the amplitude of the modulated exciting field, is also described. This technique is suitable for the measurement of the parameters of such a periodically varying plasma medium and is expected to yield direct measurements of the time-dependent properties of the plasma. (auth)

32587 PLASMA WAVE ECHOES. Etievant, C. (CEA, Fontenay-aux-Roses, France). pp 259-97 of Phenomena in Ionized Gases, 1971. /Davenport, P. A. (ed.). Oxford; Donald Parsons and Co. Ltd. (1971).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

A survey is given of experimental work on electron and ion plasma wave echoes, including experimental results demonstrating the main features of electron on ion plasma wave echoes and the effect of relaxation. Limitations of application of perturbation theory are discussed, and the saturation of echoes is explained. Headings are as follows: Simple representation of the echo process (including higher-order echoes, echoes with more than two waves, sheath echoes, and temporal echoes); second-order perturbation theory of plasma wave echoes; the saturation effect; experimental observations of electron plasma wave echoes; effect of collisions and turbulence on electron plasma wave echoes; and ion wave echoes. It was found that most of the predicted features of these echoes are in reasonable agreement with theory. The third-order resonant echo observed in the electron echo experiments is found to be a very useful tool for investigating the diffusion in velocity space due to collisions or microturbulence and, in the ion case, attenuation of a second-order echo is found to be in good agreement with that predicted by a theoretical model using a Fokker–Planck operator to take account of ion–ion collisions. Echoes appear to be a powerful tool for measuring relaxation times and for testing the validity of collision operators used in the theory of plasmas. Potential applications in plasma are discussed. (39 references) (UK)

32588 ION WAVES AND IONISATION WAVES. Pekarek, L. (Inst. of Physics, Prague). pp 365-403 of Phenomena in Ionized Gases, 1971. /Davenport, P. A. (ed.). Oxford; Donald Parsons and Co. Ltd. (1971).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

It is stated that two main classes of slow waves are responsible for most of the longitudinal instabilities of gas-discharge plasma. These are (1) ion-acoustic (or electro-acoustic) waves, observed at pressures $<10^{-2}$ torr, and (2) ionization waves, propagating at pressures $>10^{-2}$ torr. Recent progress in studies in this field is reviewed, and a comparison is made of the phenomenological properties of the two wave classes and their physical mechanisms. Some experimental results are given for Ne, He, and Ar. Attention is confined mainly to cylindrical discharge plasmas without magnetic field. Transitions from ion-acoustic to ionization waves are discussed. (97 references) (UK)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 32298 and 32671.

32589 (AD–734401) SAM-A: AN ADJOINT MONTE CARLO GAMMA-RAY TRANSPORT CODE. Final Report. Guber, W.; Steinberg, H. A. (Mathematical Applications Group, Inc., White Plains, N. Y.). Oct 1971. Contract DASA01-71-C-0027. 26p. NTIS.

SAM-A is a time-dependent adjoint gamma ray Monte Carlo code used to calculate primary and secondary gamma ray data at a point or volume detector. SAM-A is part of the SAM-CE system, which also contains an ENDF/B Round 2 neutron cross section processing code (ENDTS) and a general-purpose forward Monte Carlo code (SAM-F). SAM-A and SAM-F use combinatorial geometry for the description of complex three-dimensional configurations. (auth) (USGRDR)

32590 (CERN–71-16(Vol.1 and 2)) INTERNATIONAL CONGRESS ON PROTECTION AGAINST ACCELERATOR AND SPACE RADIATION, CERN, GENEVA, SWITZERLAND, APRIL 26–30, 1971. Proceedings, Vol. 1 and Vol. 2. Baarli, J.; Dutrannois, J. (eds.) (European Organization for Nuclear Research, Geneva (Switzerland)). 1 Jul 1971. 1116p. (In several languages). (CONF-710423–(Vol.1 and 2)).

Sixty-three complete papers and one abstract are included in the two volumes, grouped into parts as follows: (1) biological aspects of space- and accelerator-produced radiation, (2) dosimetry, (3) radiation problems in space and supersonic transport, and (4) radiation protection in accelerator installations. A separate abstract is included here for each of 56 of the complete papers, the other 7 having already appeared in NSA; for abstracts of these 7, see NSA Vol. 25, abstract nos. 36610, 41127, 45839, 45840, 46966, 49283, and 53407. (L.M.T.)

For abstracts of individual papers see: 31052–31055, 31102–31106, 31219, 31226, 31237, 31279, 31286–31294, 31318–31324, 31629–31635, 31640–31647, 31687–31689, 31693, 31694, 31705, 31860, 32591–32593, 32605, and 32608.

32591 (CERN–71-16(Vol.1 and 2), pp 231-45) SOME STUDIES IN PION BEAM DOSIMETRY. Turner, J. E.; Wright, H. A.; Hamm, R. N. (Oak Ridge National Lab., Tenn.); Baarli, J.; Dutrannois, J.; Sullivan, A. H. (European Organization for Nuclear Research, Geneva (Switzerland)).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

A detailed Monte Carlo program was written for the penetration of charged pions in matter. The incident particles can be made to enter a target with any given distribution in space and with any momentum distribution. The program was used to analyze the absorbed dose at various depths in a water target exposed to a pion beam. The energy loss of an individual pion is traced in the calculation as it slows down in the target until it has an inelastic nuclear collision or comes to rest; elastic nuclear scattering from hydrogen and multiple Coulomb scattering from all nuclei are included. It was found that measurement of two quantities from a depth-dose curve in water suffices to identify the beam characteristics rather well: these are the depth at which the peak dose rate occurs and the width of the peak at 80% maximum after subtraction of muon and electron contamination. A calculated depth-dose curve is compared with one obtained by using the negative pion beam from the CERN 600-MeV synchrocyclotron. Almost all of the dose results from the capture of stopped π^-. The effects of various parameters on the detector response were calculated; these parameters included the momentum distribution of the incident particles, the radii of the detector and of the beam, multiple scattering, and the degree of nonuniformity of pions in the beam. (8 figures, 1 table) (R.W.R.)

32592 (CERN–71-16(Vol.1 and 2), pp 492-500) RESULTS OF THE INTEGRATED RADIATION DOSE MEASUREMENTS ON THE "SOYUZ" SPACESHIPS. Akatov, Yu. A.; Arkhangelskii, V. V.; Blashkovskii, V. A.; Markelov, V. V.; Smirenny, L. N. (Ministerstvo Zdravookhraneniya SSSR, Moscow. Institut Mediko-Biologicheskikh Problem).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

Integrated doses at different points of the cosmonaut's body were determined in addition to dose rate measuring in the modules of the vehicle. Personal monitoring was accomplished by a passive dosimetry package, each package containing thermoluminescent glass dosimeters of two types and nuclear emulsions of four types. The individual doses to the cosmonauts correlated with the data from the "on-board" dosimeters permitted an assessment of the radiation situation inside the ship. Results are presented from the flights of October 1968, January 1969, October 1969, and June 1970. (L.M.T.)

32593 (CERN–71-16(Vol.1 and 2), pp 512-23) PRELIMINARY RESULTS OF MEASUREMENTS OF HEAVY PRIMARIES IN THE REGION OF SUPERSONIC TRANSPORT USING PLASTIC STACKS. Allkofer, O. C.; Enge, W.; Heinrich, W.; Roehrs, H. (Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

Intensities of thin-down hits are determined for heavy primaries with charges $Z \geq 6$ for different energy regions, e.g., for different deep layers in the plastic stack. The frequencies of thin-down hits on the surface and in the interior of the body (embryo) for an SST traveler can be determined from these results. The thin-down intensities measured in the deeper layers of the plastic stack can be directly compared with the intensities in tissue in the interior of the body, since the fragmentation probabilities and the interaction mean free paths for heavy ions can be assumed to be equal in plastic and in tissue. If the thin-down intensity in the interior of the body is calculated by replacing the tissue by an equivalent amount of g/cm^2 air, then values must be obtained which are too low since fragmentations occur more frequently in air than in tissue. (auth)

32594 (EUR–4666) RESEARCH INTO THEORETICAL MICRODOSIMETRY IN THE REGION OF INTERFACES AND IN CAVITIES. Annual Report, 1970. (Toulouse Univ. (France). Centre de Physique Atomique et Nucleaire). 1971. 56p. (In French). Dep. NTIS (U. S. Sales Only). EUR FF 7,75.

Mathematical techniques for tracing the spatial evolution of various dosimetric parameters on penetration of heterogeneous environments by means of photons or electrons are presented. These are applied to geometric configurations encountered in problems of biological dosimetry. (auth)

32595 (HASL-TM–70-1) RADIATION PHYSICS DIVISION PROGRESS REPORT, 1969. McLaughlin, James E. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Feb 1970. 61p. Dep. NTIS.

A nontechnical review of the activities of the Radiation Physics Division for the year 1969 is given. The work is divided into two project areas, radiation transport and radiation interaction and dosimetry. Some data are given on cosmic-ray fluxes, gamma depth dose distributions, and radiation dose near a 3-GeV proton synchrotron. Most of the work discussed has been presented in the form of reports or journal articles. (7 figures, 2 tables, 49 references) (R.W.R.)

32596 (SC-RR–710870) FIELD GENERATION WITHIN A LOSSY DIELECTRIC CYLINDER EXCITED BY A RADIATION PULSE. Mangan, D. L.; Scrivner, G. J. (Sandia Labs., Albuquerque, N. Mex.). Feb 1972. 26p. Dep. NTIS.

A transient electromagnetic field problem is solved for a finite-length cylindrical cavity bounded by perfectly conducting walls. The cavity is filled with a homogeneous lossy dielectric material. Analytic solutions for the relevant components of the electric and magnetic fields generated by an axially propagating current pulse are presented. Results obtained for various sample problems are discussed. (auth)

32597 ABSORPTION OF ENERGY BY SUBSTANCES DURING IRRADIATION WITH AN ELECTRON BEAM. Vorob'ev, A. A.; Dergobuzov, K. A.; Evdokimov, O. V.; Kononov, B. A. (Tomsk Polytechnical Inst., USSR). This paper was summarized in Khim. Vys. Energ.; 3: No. 6, 525-6(Nov-Dec 1969). (In Russian).

Full copy of this paper is held by DTIE.

Results are given of systematic measurements of the distribution of absorbed energy (DAE) and of the energy removed by electrons, in carbon, aluminum, copper, cadmium, tin, and lead plates with thicknesses greater than the free paths of electrons with energies of 3.8, 6.9, and 9 MeV, accelerated in a betatron. The measurements were performed by the ionization method. (auth)

32598 SURFACE EFFECTS OF HIGH-ENERGY X RAYS AT OBLIQUE INCIDENCE. Orton, Colin G.; Seibert, Joan B. (New York Univ., N. Y.). Brit. J. Radiol.; 44: No. 527, 895-6(Nov 1971).

The dose on the surface of a cylindrical tissue-equivalent rubber phantom 30 cm in diameter was measured using various thicknesses of polyethylene film as buildup material. Irradiations were made with a Picker C-10,000 teletherapy unit using a thin layer (less than 0.02 cm thick) of LiF powder as dosimeter. For small fields, it was found that peak buildup occurred at a depth close to that calculated in a previous paper. However, for a 25 × 25 cm field, the experimental value was significantly less than that predicted. The reason for this field size dependency is discussed. (M.H.R.)

32599 VARIATIONAL METHODS AND TRANSPORT THEORY. Hopps, John Henry Jr. Waltham, Mass.; Brandeis Univ. (1971). 205p. University Microfilms Order No. 71-30,133.

Thesis.

It is shown that the majority of the basic variational principles that have been employed in transport theory are natural extensions of the basic variational idea of Onsager, which is connected with his principle of maximum entropy production. These basic variational principles, as are demonstrated, may be modified in a somewhat simple and systematic way to approximate arbitrary functionals, to handle nonadjoint and nonlinear operators, to include initial and boundary conditions, to deal with discontinuous distribution functions, to compute functionals correct to arbitrary order in the trial function errors, and in certain instances to compute functionals exactly using incorrect trial functions. Many of these modifications have yet to be exploited in transport theory calculations. It is shown how some of these modifications may be incorporated for treating the problems of radiative transfer in slabs, and the Couette flow and Kramer's problem of rarefied gas dynamics. In general, the variational method does not yield a definite bound on the computed functional. Formal procedures are discussed for bounding, on both sides, functionals—even in the cases of nonadjoint and nonlinear operators. It is shown that the selection of the trial functions is of comparable importance to finding a suitable functional. In fact in the case of several functionals, it is solely the trial function choice that computationally distinguishes the variational methods from other methods of analysis. The theory of light scattering in fluids is treated using the flexibility of the variational methods. Analytical results are obtained for the spectrum of light scattering from simple gases which have the correct behavior over all ranges of frequency shifts and wave vectors. These analytic results are not only applicable to constant temperature scattering, but should also be capable of correctly describing the temperature dependence of the scattering spectrum. The methods as applied to the light scattering problem, i.e., the formulation of the functional and the selection of the trial solutions, give immediate insight into how uniformly valid analytical results may be obtained over wide ranges of densities for many other problems of kinetic theory or gas dynamics. (Diss. Abstr. Int., B)

32600 USE OF NUMERICALLY INVERTED LAPLACE TRANSFORMS IN TIME-DEPENDENT TRANSPORT CALCULATIONS. Renken, James H.; Biggs, Frank (Sandia Labs., Albuquerque, N. Mex.). J. Comput. Phys.; 9: No. 2, 318-38 (Apr 1972).

A time-dependent transport problem in which a monoenergetic point source emits a pulse of radiation into an infinite medium was solved by Laplace transform techniques. Auxiliary information inferred from the physical nature of the problem is incorporated into the Laplace inversion procedure to eliminate the oscillatory solutions that usually result from attempts to numerically invert Laplace transforms. This simultaneous utilization of mathematical and physical information has made it possible to obtain credible time-dependent solutions for the transport problem under consideration. (auth)

32601 CONTRIBUTION OF SURFACE LOSSES TO THE STOPPING POWER OF MATTER FOR CHARGED PARTICLES. Ashley, J. C.; Ritchie, R. H. (Oak Ridge National Lab., Tenn.). Phys. Rev., B; 5: No. 9, 3485-7(1 May 1972).

A simple expression is derived for estimating the contribution of surface losses to the stopping power of foils with plane parallel surfaces for normally incident nonrelativistic charged particles. Estimates are presented for electrons incident on foils of carbon and aluminum. The simple expression is modified in an approximate way to apply to the polycrystalline samples used in the work of Ichinokawa et al. and an estimate of the surface-loss contribution to the stopping power of polycrystalline graphite for electrons is given. (auth)

32602 MONTE CARLO SIMULATION OF THE BEHAVIOR OF ENERGETIC IONS IN POLYATOMIC TARGETS. Ishitani, T.; Shimizu, R.; Murata, K. (Osaka Univ.). Phys. Status Solidi (b); 50: No. 2, 681-90(1 Apr 1972).

The behavior of energetic ions in polyatomic targets is simulated by the Monte Carlo technique, which is based on a single scattering model taking account of nuclear and electronic stopping. The results follow the experiments fairly well as to range and energy distribution of transmitted ions through thin films. The present simulation is, in principle, applicable to any combination of ion beam and target. (auth)

32603 NONLINEAR RESPONSE OF BOUND ELECTRONS TO X RAYS. Jha, Sudhanshu S. (Tata Inst. of Fundamental Research, Bombay); Woo, James W. F. Phys. Rev., B; 5: No. 10, 4210-12(15 May 1972).

In the high-frequency limit, general expressions for second- and third-order induced electronic current densities in a medium are derived. These are valid for any medium with arbitrary spatial electronic-density variations. It is shown that the second-order current density at x-ray frequencies depends directly on the gradient of the unperturbed electronic density, so that it is sensitive to density variations both near the surface and near the ionic cores in a solid. (auth)

32604 EFFECT OF PRIMARY-ELECTRON DIFFUSION ON SECONDARY-ELECTRON EMISSION. Bennett, Alan J.; Roth, Laura M. (General Electric Research and Development Center, Schenectady, N. Y.). Phys. Rev., B; 5: No. 11, 4309-24(1 Jun 1972).

Some effects of primary-electron diffusion on secondary-electron emission from a free-electron model of a polycrystalline target are considered—in particular, the angular distribution and energy dependence of the secondaries. The distributions of primary electrons due to incident 2- and 10-keV monoenergetic beams are obtained by means of a Boltzmann equation. The fraction of backscattered primaries is found to be in good agreement with experiment. The primary distributions excite distributions of secondary electrons which diffuse toward and are transmitted through the surface. In accord with experiment the large angular anisotropy in the emitted secondary-electron distribution predicted by Stoltz is found to be greatly reduced by the primary diffusion. The transmission coefficient, not included in previous calculations, is also of importance in determining the characteristics of the observed secondaries. (30 references) (auth)

Radiation Source Calibration and Standardization

Refer also to abstract 31214.

32605 (CERN-71-16(Vol.1 and 2), pp 773-97) DOSE VS. ANGLE AND DEPTH PRODUCED BY 20- TO 100-MeV ELECTRONS INCIDENT ON THICK TARGETS. Wyckoff, J. M.; Pruitt, J. S. (National Bureau of Standards, Washington, D. C.); Svensson, Goren (Stanford Linear Accelerator Center, Calif.).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

Experiments performed with a thick Ta target bombarded by electrons with energies of 20, 30, and 100 MeV are reported. The dose produced by electrons and photons in a polymethylmethacrylate phantom encircling the target was measured at several angles at each energy with LiF thermoluminescent dosimeters calibrated with ^{60}Co γ rays. The absolute accuracy of the measurements is of the order of 10%. In the forward direction the dose distribution is mainly produced by bremsstrahlung, but secondary electrons incident on the phantom contribute a dose that increases in relative importance with increasing angle. The electron distribution is not a sensitive function of the energy of the incident electrons. Only a minute fraction of the measured dose was attributed to neutrons, but the neutron dose equivalent could be significant for a biological system, at least at 100 MeV and large angles. The angular and depth distribution of dose at 30 MeV is in excellent agreement with the theoretical predictions of Berger and Seltzer at this energy, except for too large a surface dose in the experimental distribution near 30 and 60°. This difference could have considerable clinical significance, but it is not known whether its causes are experimental or theoretical in nature. The measurements were also compared with published data describing angular distributions for a thin target, depth-dose curves in plastic media, and determinations of the maximum dose that can be produced in a tissue-like medium. The last comparison is absolute and provides a quantitative measure of the largest dose that can be obtained at any energy between 1 and 100 MeV. (12 figures, 1 table) (R.W.R.)

32606 ELECTRONIC ASSAY OF ^{252}Cf NEUTRON SOURCES. Herold, T. R. (Savannah River Lab., Aiken, S. C.). Nucl. Technol.; 14: No. 3, 269-78(Jun 1972).

A new electronic method was developed that requires about 10 minutes to assay ^{252}Cf sources between 1 microgram and 50 milligrams. The assay is made by placing the ^{252}Cf source in the center of a polyethylene moderator and measuring the resulting thermalized neutrons with fission counters in the moderator. All measurements are referenced to a ^{252}Cf source calibrated with a manganese sulfate bath by the National Bureau of Standards. Sources smaller than 1 microgram and larger than 50 milligrams could be similarly assayed with appropriate modifications to the moderator. The new method is routinely compared with the manganese bath method to determine the precision and sensitivity of the measurements so that the new method can be used as a secondary standard. Measurements of ^{252}Cf content agree with manganese sulfate bath determinations to within ± 0.6%. The present design is tailored for a fission neutron spectrum but could be used with proper calibration in assaying between 10^6 and 10^{11} neutrons/second from sources having different spectra. (auth)

32607 NONRADIOACTIVE REFERENCE MATERIALS. Hilaire, M.; Le Gallic, Y. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 163, 67-72(Oct 1971). (In French).

If precise radiometrology measurements are to be made, the low activities of environmental materials must be taken into consideration. In order to check the activities of such materials, standard references that can be compared with industrial materials are required. The national reference standards of Cu, steel, and Pb are discussed, particular attention being given to α, β, and γ activities and purities. The reference contaminations are of the same order of magnitude as the detection thresholds i.e. 10^{-9} μCi g^{-1}. (France)

Shielding Calculations and Theory

Refer also to abstracts 31644, 32592, 32771–32773, and 32775–32785.

32608 (CERN–71-16(Vol.1 and 2), pp 501-8) SOME ASPECTS OF ACTIVE SHIELDING AGAINST THE RADIATION IN SPACE. Morozov, D. Kh.; Ryabova, T. Ya.; Trukhanov, K. A.; Sedin, G. Z.; Tsetlin, V. V. (Ministerstvo Zdravookhraneniya SSSR, Moscow. Institut Mediko-Biologicheskikh Problem).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The author's results show that, in many cases, both electrostatic and magnetic shielding have an advantage over the equivalent passive shielding. (L.M.T.)

PHYSICS (SOLID-STATE)

Radiation Effects

Refer also to abstracts 31563, 31569, 31606, 32288, and 32390.

32609 ROLE OF AUGER EFFECT IN THERMOSTIMULATED PHENOMENA IN IONIC CRYSTALS. Tuan, B. T.; Velicky, B.; Bohun, A. (Inst. of Solid State Physics, Prague). Z. Phys.; 251: No. 4, 289-99(1972).

Absorption and thermostimulated luminescence simultaneously with electric conductivity in KI crystals irradiated with x-rays at liquid-nitrogen temperature were measured. The kinetics of these and many other similar results obtained in other alkali-metal halides are interpreted on the basis of the Auger process occurring in consequence of the recombination of free holes with localized electrons in F centers. (auth)

32610 RADIATION DAMAGE EFFECTS IN ELECTRON-IRRADIATED CADMIUM SULFIDE PLATELETS AT LOW TEMPERATURE. Elsby, C. Neale. Wright-Patterson AFB, Ohio; Air Force Inst. of Tech. (1971). 139p. University Microfilms Order No. 72-12,903.

Thesis.

A study was made of the luminescence properties of cadmium sulfide platelets bombarded at near liquid helium temperature with fast electrons at energies above 100 keV. Photoluminescence and cathodoluminescence spectra were evaluated. Post-irradiation annealing and thermal and optical quenching experiments were conducted. Bound-exciton luminescence decreases in intensity with irradiation with the exception of the line near 4867 Å which was enhanced in some samples. Annealing to 300°K causes partial restoration of luminescence. Theory indicates that the luminescence decreases because of trap production and exciton–center destruction. Broad-band luminescence is produced at 5180 Å and 1.12μm during low-temperature irradiation. Luminescence at 5140 Å, 7300 Å, and 1.65 – 2.0 μm is reduced during irradiation. Annealing to 300°K removes the 1.12-μm luminescence, restores the 5140 Å and 1.65-μm bands and results in the production of a strong band at 7330 Å. Annealing experiments suggest that defect migration occurs in several stages between 80 and 300°K. Activation energies of 0.22 to 0.30 eV are assigned to interstitial migration. An energy-level model is presented to describe the luminescence bands. A displacement threshold for the cadmium atom is found to exist at 314(± 5) keV. Broad-band luminescence changes are interpreted as being caused by simple defect production. (Diss. Abstr. Int., B)

32611 PHOTOCONDUCTIVITY STUDIES OF RADIATION-INDUCED DEFECTS IN SILICON. Young, Rosa Ting-i. Troy, N. Y.; Rensselaer Polytechnic Inst. (1971). 106p. University Microfilms Order No. 72-10,870.

Thesis.

The annealing behavior and the uniaxial stress responses of the radiation-induced defect causing the $E_c - 0.75$ eV, $E_c - 0.54$ eV, $E_c - 0.42$ eV, and $E_c - 0.18$ eV photoconductivity energy levels in n-type silicon were studied after 1.5-MeV electron and ^{60}Co gamma irradiation. The results suggest that the $E_c - 0.75$ eV level arises from the electronic transition of the neutral charge state of the divacancy to the conduction band, the $E_c - 0.18$ eV level arises from the A-center defect which exhibits only one kind of stress response, i.e., the atomic redistribution among the allowable orientations. No electronic response can be observed for the A-center in the present photoconductivity measurements. The data fit very well with the A-center model given by G. D. Watkins and J. W. Corbett. The $E_c - 0.42$ eV level was quite complicated. Besides the radiation-induced divacancy defect located near this level, evidence is presented that the E-center defect and some additional trap center inherent as an in-grown defect in the sample also give rise to this level. The $E_c - 0.54$ eV level anneals around 150°C. Whether it really arises from the single charge state of the divacancy or not is still a question. (Diss. Abstr. Int., B)

32612 PROTON SPIN–LATTICE RELAXATION IN IRRADIATED POLYCARBONATES. Grosescu, R. (Inst. for Atomic Physics, Bucharest). pp 561-2 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

The spin–lattice relaxation time T_1 of protons was measured in Lexan after irradiation with 2-MeV electrons at 77°K. The effects of paramagnetic center concentration, temperature, and magnetic field on T_1 were studied. (D.L.C.)

32613 ESR STUDY OF PARAMAGNETIC DEFECTS IN NEUTRON-IRRADIATED LiF CRYSTALS. Raoux, D.; Causa, M. T.; Taupin, C. (Faculte des Sciences, Orsay, France). pp 902-4 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

ESR was used to study two defects formed in LiF crystals irradiated by 1.5×10^{19} or 10^{20} n/cm^2 at 77°K. The first center is a tritium atom, which can be found on several lattice sites, while the second one seems to be a $(F_3)^{2-}$ molecular ion. Their spectra are described, and qualitative interpretations and calculations are given. (D.L.C.)

32614 TEMPERATURE AND IRRADIATION INFLUENCE ON Cu^{2+} ESR SPECTRUM IN $K_2Zn(SO_4)_2.6H_2O$. Giurgiu, L. V.; Nicula, Al.; Darabont, A. (Univ. of Cluj). pp 913-17 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

The ESR spectra of Cu^{2+}-doped $K_2Zn(SO_4)_2 \cdot 6H_2O$ single crystals were studied at 77 and 290°K before and after uv, x, and γ irradiation. The crystal field is changed from rhombic to tetragonal on going from 77 to 290°K. X or γ rays produce SO_4^- radicals, with ^{33}S hyperfine structure. Uv radiation converts the single crystals to the polycrystalline form. (D.L.C.)

32615 SYMMETRY OF PARAMAGNETIC CENTERS AND THE TYPE OF IRRADIATION. Nicula, Al.; Darabont, Al.; Peteanu, M. (Univ. of Cluj). pp 918-23 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

The effects of the radiation type on the ESR center symmetry of Ba-, Ca-, and Sr-doped NaCl single crystals were studied, using uv, x, and γ rays either singly or in combination. The results indicate that uv radiation favors the formation of lower symmetry centers (rhombic and axial), while x and γ rays give rise to cubic centers. Model descriptions of the centers are given. (D.L.C.)

32616 ESR INVESTIGATIONS OF IRRADIATED ALKALINE EARTH FLUORIDE CRYSTALS CONTAINING Gd^{3+} CENTERS. Bevolo, A. J.; Lee, S. (St. Louis Univ.). pp 933-6 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

ESR investigations were conducted of the new trigonal Gd^{3+} center with large crystal-field splitting ($|b_2^0| \sim 2899 \times 10^{-4}$ cm^{-1}) in x-irradiated CaF_2 containing other types of Gd^{3+} centers and some SrF_2 and BaF_2 crystals doped with Gd^{3+} ions. The results show that the $Gd^{3+}:OH^-$ center can be completely destroyed by x rays, and that production of the new trigonal Gd^{3+} center in CaF_2 is a common occurrence, except for samples containing only the $Gd^{3+}:OH^-$ center. The models proposed for the various noncubic Gd^{3+} centers are questioned. (D.L.C.)

32617 RADIATION PARAMAGNETIC DEFECTS IN SCHEELITE COMPOUNDS. Solntsev, V. P.; Shcherbakova, M. Ya. (Inst. of Geology and Geophysics, Novosibirsk, USSR). pp 937-42 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

An EPR investigation was conducted on the paramagnetic defects produced in $MgWO_4$, $CaWO_4$, $SrWO_4$, and $BaWO_4$ crystals by γ irradiation. The W^{5+} and Mo^{5+} spectra were measured at 77°K, and the g-tensors and hfs constants are tabulated. The centers WO_4^- and $[WO_4-WO_4]^{3-}$ were produced, the latter in an unusually large amount. The $[WO_4-WO_4]^{3-}$ centers partly compensate for the unparamagnetic defects produced by the irradiation. (D.L.C.)

32618 EPR OF ATOMIC HYDROGEN IN IRRADIATED ALKALINE EARTH SULFATES. Belonogov, A. M.; Grammakov, A. G.; Serdyuk, A. S.; Suppe, S. A. (Electrotechnical Inst., Leningrad). pp 943-4 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

The EPR of the hydrogen atom was measured in x-irradiated baryte ($BaSO_4$) and calcinated gypsum ($CaSO_4 \cdot \frac{1}{2} H_2O$). The g-factors and hfs constants were found practically equal ($g = 2.0020 \pm 0.0003$, $A = 1405 \pm 2$ Mc/sec) in both materials. These values are normal and agree with those for irradiated frozen water–acid mixtures, and therefore the peculiar model proposed for $CaSO_4$ is not necessary. (D.L.C.)

32619 TITANIUM CENTERS INDUCED IN BORATE GLASSES BY IRRADIATION. Arafa, Salah (American Univ., Cairo). J. Amer. Ceram. Soc.; 55: No. 3, 137-41(Mar 1972).

The electron paramagnetic resonance of alkali borate glasses containing Ti was observed at 9.1 GHz before and after room-temperature x irradiation. The radiation induced spectra can be separated into the well-known complex borate resonance with an average g value greater than that of the free electron (2.0028) and a resonance with a lower g value. The latter resonance consists of two asymmetric ESR lines, one broad and the other narrow, whose characteristics are reported. These lines were not observed in the corresponding Ti-free base glasses; they arose from induced Ti centers. The broad asymmetric line (T_1) corresponded to a Ti^{3+} ion in sixfold coordination, whereas the narrow asymmetric line (T_2) corresponded to a Ti^{3+} ion in a different structural configuration. Lines T_1 and T_2 were stable at room temperature, not easily saturated with microwave power, and exhibited behavior independent of the complex borate resonance. The total relative intensity of these lines depended on the total Ti concentration in the glass, the Ti^{4+}/Ti^{3+} ratio in the glass before irradiation, and the structure of the glass. (auth)

32620 RADIATION DAMAGE CENTRE IN GALLIUM PHOSPHIDE CONTAINING BORON. Morrison, S. R.; Newman, R. C.; Thompson, F. (Thomson Physical Lab., Reading, Eng.). J. Phys., C (London); 5: No. 6, L46-9(28 Mar 1972).

It is shown that irradiation of either n- or p-type gallium phosphide by 2-MeV electrons at 300°K reduces the concentration of boron initially present on gallium lattice sites. Local-mode absorption bands due to a defect center involving a single boron atom were observed at 849 (^{11}B) and 882 (^{10}B) cm^{-1}. It is thought that the boron atom occupies an interstitial site in these defects. (auth)

32621 F CENTERS IN $SrCl_2$. Lefrant, S.; Jumeau, D.; Taurel, L. (Paris Univ., Orsay, France). Phys. Status Solidi (b); 50: No. 2, K101-3(1 Apr 1972).

An $SrCl_2$ single crystal was heated at 750°C for several hours in the presence of an alkaline earth metallic vapor and hydrogen was then quenched at room temperature. After this treatment, no ESR spectrum appeared. However, if the crystal was then x irradiated at 90°K, an ESR spectrum was obtained. If x-irradiated crystal was warmed from 90 to 240°K, very important changes in the ESR and in the optical absorption spectrum appeared. It is shown that the ESR spectrum observed at 240°K was due to F centers composed of an electron trapped in a halogen vacancy. However it is pointed out that, owing to the long relaxation time, the ESR resonance of the F centers can only be observed with a low radiofrequency field power. (P.C.H.)

32622 POLARIZED LUMINESCENCE OF In^{++} AND $In^{++}V_c$ CENTRES IN KCl : In CRYSTALS. Lukantsever, N.; Osminin, V.; Zazubovich, S. (Inst. of Physics and Astronomy, Tartu). Phys. Status Solidi(b); 50: No. 2, 771-83(1 Apr 1972).

Polarized luminescence was observed for In^{2+} ($hv^I_m = 2.12$ eV) and $In^{2+}v_c^-$ ($hr^I_m = 1.75$ eV) centers in x-irradiated KCl : In. Spectral and polarization characteristics of the luminescence were investigated. The symmetry of excited In^{2+} centers was established to be tetragonal. The energy level diagram and the possible models of the In^{2+} centers in the ground and excited electronic states are considered. It is assumed that In^{2+} and $In^{2+}v_c^-$ centers in the excited state may be represented as $In^+Cl_2^-$ and $In^+v_c^-Cl_2^-$ quasi-molecules, respectively. (auth)

32623 LUMINESCENCE DUE TO TRAPPING OF HOLES BY In^+ AND $In^+V_c^-$ CENTERS IN KCl:In. Zazubovich, S. (Inst. of Physics and Astronomy, Tartu). Phys. Status Solidi(b); 50: No. 2, 785-93(1 Apr 1972).

The trapping of holes by In^+ and $In^+v_c^-$ centers in KCl : In was found to be accompanied by luminescence of the same spectral composition as the emission spectra of In^{2+} and $In^{2+}v_c^-$ centers, respectively. The processes of migration and trapping were investigated for holes thermally or optically released from In^{2+}, V_k, V_F, and other hole centers. (auth)

32624 VACANCY-DONOR COMPLEXES IN γ-IRRADIATED PHOSPHORUS-DOPED GERMANIUM. Emtsev, V. V.; Korkhashkina, R. L.; Mashovets, T. V. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Status Solidi (a); 10: No. 1, 43-8(16 Mar 1972).

It is shown that the n–p conversion of phosphorus-doped Ge under γ irradiation is related to a concentration decrease of the P donor states. This might be explained by the fact that generated lattice vacancies can be trapped by substitutional atom impurities. An energy level introduced by γ irradiation could not be associated with the VP complex, thus the electronic states of this center are obviously located in the valence band. The concentration of the ($E_v + 0.12$) eV acceptor level increases after the n–p conversion. This level is most likely associated with the donor–divacancy complex. When the "ultimate state" is achieved, the Fermi level coincides with the group III acceptor level at 0°K. (auth)

32625 MEKHANIZMY RELAKSATSIONNYKH YAVLENII V TVERDYKH TELAKH. (Mechanisms of Relaxation Phenomena in Solids). Postnikov, V. S.; Gordienko, L. K. (eds.). Moscow; Izdatel'stvo Nauka (1972). 296p.

Recent developments in solid state physics, and the theory and practice in dislocation phenomena are discussed in this collection of 62 papers by various authors. The papers are divided into four groups under the headings: relaxation stresses and consequences, internal friction, electrical and mechanical relaxation, and magnetic relaxation. Six papers were selected for separate abstracting because of their pertinence to nuclear science; these six abstracts are grouped together below. (K.S.W.)

For abstracts of individual papers see: 32626, 32627, and 32707–32710.

32626 CHANGES IN ULTRASONIC ATTENUATION CAUSED BY PINNING DISLOCATIONS AFTER GAMMA IRRADIATION OF PURE COPPER. Lyukke, K.; Vinterkhager, P. pp 110-20 of Mekhanizmy Relaksatsionnykh Yavlenii v Tverdykh Telakh. /Postnikov, V. S. (ed.). Moscow; Izdatel'stvo Nauka (1972). (In Russian).

Ultrasonic attenuation in the MHz region of frequencies was measured in monocrystals of copper (99.999%) after 3-MeV gamma irradiation and subsequent annealing at 220 to 400°K. The mechanisms involved in the three stages of recovery are discussed. (tr-auth)

32627 STRESS RELAXATION DURING INTERACTION OF DISLOCATIONS WITH RADIATION DEFECTS. Soifer, Ya. M.; Sorokin, Yu. G. pp 159-63 of Mekhanizmy Relaksatsionnykh Yavlenii v Tverdykh Telakh. /Postnikov, V. S. (ed.). Moscow; Izdatel'stvo Nauka (1972). (In Russian).

The internal friction of NaCl monocrystals was investigated with a triplex compound vibrator after deformation of the crystals by 1 to 2% rolling and irradiation by a ^{60}Co γ source at various doses (from 10^4 to 10^8 R). Immobilization of the dislocation centers and their stability are discussed. (tr-auth)

32628 RADIATION EFFECTS ON THE MAGNETIC PROPERTIES OF IRON–NICKEL ALLOYS OF THE INVAR TYPE. Chamberod, A.; Billard, L.; Rechenberg, H. (CEN, Grenoble, France). Solid State Commun.; 10: No. 6, 483-8(15 Mar 1972). (In French).

The irradiation of iron–nickel alloys of 30, 32, 35, and 40% nickel content was undertaken to study its influence on the magnetic properties of invar. The initial results obtained from measurements of the magnetization and from the Mössbauer effect, showed that electron irradiation could lead to the appearance of an ordered phase. (auth)

32629 CARRIER GENERATION IN ORTHORHOMBIC SULFUR CRYSTALS BY PULSED X-RAYS. Hayashi, Kotaku (Osaka Univ.); Watanabe, Yasutaka; Inuishi, Yoshio. Technol. Rep. Osaka Univ.; 21: 521-7(Oct 1971).

The mobility and carrier number in orthorhombic sulfur crystals bombarded with pulsed x rays at 100 kV were measured as a function of the applied electric field or x-ray intensity at room temperature. Results show that the hole mobility is 0.26 cm^2/V sec in fields from 20 to 56 kV/cm and the produced carrier number is approximately proportional to the square of the intensity. (auth)

32630 REACTOR-IRRADIATION-ENHANCED HETERODIFFUSION IN SILICON. Koifman, A. I.; Niyazova, O. R. (Inst. of Nuclear Physics, Tashkent). Phys. Status Solidi (a); 10: No. 1, 59-65(16 Mar 1972).

The in-pile irradiation-enhanced diffusion of gold and zinc at 400°K in n-type silicon was investigated and their diffusion coefficients determined: 1.5×10^{-11} and 2.2×10^{-12} cm^2/sec, respectively, by irradiation with a thermal neutron flux density of 1.8×10^{13} cm^{-2} sec^{-1}. It was established that diffusion occurs according to a dissociative mechanism. Gamma radiation plays a decisive part in enhancing the diffusion of these impurities. The neutron component of the in-pile radiation, which is very efficient in generating Frenkel defects, retards the gold and zinc diffusion. (auth)

32631 COLORATION OF LiF BY 56-MeV α PARTICLES AND 28-MeV DEUTERONS. II. F_2^+ CENTRE EVOLUTION. Thevenard, P.; Perez, A.; Davenas, J.; Dupuy, C. H. S. (Univ. Claude Bernard, Lyon). Phys. Status Solidi (a); 10: No. 1, 67-72(16 Mar 1972).

Optical absorption spectra were used to study F_2^+ center evolution in LiF samples bombarded with 56-MeV α particles and 28-MeV deuterons at room temperature. Results on the decay of the F_2^+ band show that it does not follow first-order kinetics. While this band decreases, a Y-band increases in the M-region at 2.74 eV. The presence of a constant OD point I, located between these two bands, allowed the calculation of the Y-band half-width (ΔE^Y = 0.240 eV). Emission spectra show that the Y-band is in fact the F_3^+-band and it suggests F_2^+ center migration by the following process: $F_2^+ + F \rightarrow F_3^+$. (auth)

32632 OPTICAL PROPERTIES OF ELECTRON- AND NEUTRON-IRRADIATED GALLIUM ARSENIDE. Vaidyanathan, K. V.; Watt, L. A. K.; Swanson, M. L. (Univ. of Waterloo, Ont. Chalk River Nuclear Labs., Ont.). Phys. Status Solidi (a); 10: No. 1, 127-37(16 Mar 1972).

Results of infrared absorption and photoconductivity measurements in electron- and neutron-irradiated GaAs are presented. The structureless absorption at 300°K in electron-irradiated samples can be expressed by $\alpha(E) = A \exp (B E^2)$, where E is the photon energy. A similar variation in absorption is observed in low-fluence neutron-irradiated samples ($<6 \times 10^{16}$ neutrons/cm^2). This variation in absorption is attributed to the presence of a tail in the density of states at the band edges. At fluences $>6 \times 10^{16}$ neutrons/cm^2, the absorption coefficient is found to vary linearly as the square of the photon energy. This behavior can be explained on the basis of the presence of disordered regions containing metallic precipitates. A broad absorption band at 1.0 eV is observed in electron-irradiated samples at low temperatures, while weak bands are observable at 0.47 and 0.25 eV at room temperature in neutron-irradiated GaAs. A model to explain the observed absorption data is proposed. (auth)

32633 BLACK-WHITE CONTRAST FIGURES FROM SMALL DISLOCATION LOOPS. II. APPLICATION OF THE FIRST ORDER SOLUTION TO SMALL LOOPS IN ION-IRRADIATED TUNGSTEN FOILS. Haeussermann, F. (Max-Planck-Institut fuer Metallforschung, Stuttgart); Ruehle, M.; Wilkens, M. Phys. Status Solidi (b); 50: No. 2, 445-57(1 Apr 1972).

Previously it was shown that small dislocation loops in bcc metals (in this case in tungsten, irradiated with 60-keV gold ions) show under certain diffraction conditions very special contrast figures. Theoretical contrast calculations using the analytical solution of the diffraction contrast differential equations, described in part I, were applied to the interpretation of the defect images. It was found that the contour diagrams calculated for a variety of defect configurations and diffraction conditions agree even for fine contrast details very well with the observed contrast figures of the defects. This comparison of the theoretical and observed images allows to identify Burgers vectors and habit planes of the small dislocation loops (diameters $\lesssim$50 Å). (auth)

32634 QUALITATIVE DESCRIPTION OF THE TRANSVERSE MOTION OF AXIAL CHANNELED PARTICLES IN THIN CRYSTALS. Armstrong, D. D.; Gibson, W. M.; Goland, A.; (and others) (Bell Telephone Labs., Murray Hill, N. J.). Radiat. Eff.; 12: No. 3-4, 143-7(Feb 1972).

The qualitative features of the angular distribution of particles emergent from thin ~1-μ, uniform single crystals of silicon and germanium for incidence at small angles to axial directions are discussed in terms of the continuum picture of particle channeling. Blocking of axially channeled particles in the transverse plane is demonstrated. Implications and possibilities arising from observation of nonequilibrium of the transverse momentum vector are discussed. The use of the radial spreading of the angular distribution to investigate the average interatomic potential distribution in the plane transverse to the axial direction is explored and perturbations due to multiple scattering in surface films or inside the crystal and to beam divergence are qualitatively considered. (auth)

32635 QUANTUM EFFECTS IN ION CHANNELING. Grasso, F.; Lo Savio, M.; Rimini, E. (Univ., Catania, Italy. Istituto Nazionale di Fisica Nucleare, Catania, Italy). Radiat. Eff.; 12: No. 3-4, 149-52(Feb 1972).

Systematic measurements of angular yields were performed by backscattering of H^+ and D^+ impinging along different axes of silicon. The aim of this investigation was to confirm some experimental results previously obtained which showed a mass dependence of the yield profiles, and to verify the interpretation proposed by De Wames et al (1970) in terms of quantum structure in the Rutherford shadow. The measurements show several oscillations in the random level lying in a range of a few times the critical angle. These fluctuations, which exhibit good reproducibility, cannot be attributed to the lattice geometry because their angular position shifts when the bombarding beam is changed from protons to deuterons of the same energy. (auth)

32636 RECIPROCITY OF ELECTRON DIFFRACTION AND ELECTRON CHANNELING. Fujimoto, F. (Tokyo Univ.); Takagi, S.; Komaki, K.; Koike, H.; Uchida, Y. Radiat. Eff.; 12: No. 3-4, 153-61(Feb 1972).

The reciprocity in electron diffraction is demonstrated in thin and thick crystals by using an electron microscope with scanning system. It is concluded that the experiment of electron channeling is identical with that of Kikuchi patterns. The diffraction patterns from thin and thick films of silicon, copper, and gold are observed with a 1-MV electron microscope and the relations between the channeling and diffraction are studied along various crystal axes. The diffraction can be classified into flower and geometrical patterns. The former is observed for gold and for the ⟨110⟩ axes in silicon and copper. In this case, the classical theory may be applicable, and the ratios between Lindhard's critical angle and the observed one are about 0.65. The relation between channeling and various well-known phenomena in electron diffraction is discussed. (auth)

32637 CHARGE-CHANGING COLLISIONS OF CHANNELED OXYGEN IONS IN GOLD. Datz, S.; Martin, F. W.; Moak, C. D.; Appleton, B. R.; Bridwell, L. B. (Oak Ridge National Lab., Tenn.). Radiat. Eff.; 12: No. 3-4, 163-9(Feb 1972).

Oxygen ions (4 to 40 MeV) with various charge states were used to study the effects of channeling upon emerging charge-state distributions and to determine the effect of channeling upon the charge-changing cross sections involved. At energies above 20 MeV, no true equilibrium is observed even for pathlength of 0.6 μm in Au channels. Instead quasi-equilibrium is found for charge states up to 6+ and strongly pathlength-dependent charge functions for 7+ and 8+ injection. The data are interpreted in terms of interaction with loosely bound outer electrons in Au. (auth)

32638 EXPERIMENTAL AND COMPUTER STUDY OF ION SCATTERING FROM SINGLE CRYSTALS. Yurasova, V. E.; Bunin, I. G.; Shulga, V. I.; Mamaev, B. M. (Moscow State Univ.). Radiat. Eff.; 12: No. 3-4, 175-9(Feb 1972).

The spatial distribution of reflected particles was experimentally studied in the case of oblique incidence of 4.5-keV Ar ions on a (001) Cu face along the (110) and (100) planes. The distribution ejection angles of the reflected particles was found to have several peaks and minima. To explain the results of these reflection experiments, a computer study was performed. The shape of the calculated spatial distribution curves appears to be very sensitive to variations of the constants in the interaction potentials. Some features of the spatial distribution of the reflected ions were shown to be connected to the motion of ions in surface semichannels. The spatial distribution of the neutral component of scattered and sputtered particles was also studied in the experiments. A predominant yield of the sputtered particles was observed not only in the low-index but also in high-index directions. (auth)

32639 CHANNELING OF LOW ENERGY IONS ON SINGLE CRYSTAL SURFACES. Arifov, U. A.; Gruich, D. D.; Ermakov, G. E.; Khalmirza'ev, E. (Inst. of Electronics, Tashkent). Radiat. Eff.; 12: No. 3-4, 181-2(Feb 1972).

It has been shown previously that the series of maxima and minima observed in the angular distribution of ions scattered by single crystals or passed through thin films at high ion energies are explained by the channeling effect. A study was made of the channeling effect of alkali metal ions in W, Mo, and KCl single crystals under high vacuum (5×10^{-8} torr) within the prethreshold energy range (50 to 400 eV) where channeling can still be traced. (auth)

32640 SEMICONDUCTOR PHYSICS AND CHANNELING. Mayer, J. W. (California Inst. of Tech., Pasadena). Radiat. Eff.; 12: No. 3-4, 183-91(Feb 1972).

Despite early predictions, channeling effect measurements have not yet been applied to a broad range of problems in semiconductor physics. The sensitivity of the present techniques to dopant atoms and lattice disorder is not high enough to be of general interest and the interpretation of experimental data is often uncertain. One clear area of application is in the field of heavily doped or highly disordered semiconductors; ion implantation is the classic example in this category. Other examples include diffusion, alloying, epitaxial layers, heterojunctions, and compensation effects. (auth)

32641 FLUX ENHANCEMENT AND LATTICE SITE LOCATION. Morgan, D. V. (Univ. of Leeds, Eng.); Van Vliet, D. Radiat. Eff.; 12: No. 3-4, 203-9(Feb 1972).

In a previous publication (1971) the preliminary results of computer calculations of the flux enhancement of channelled ion beams were outlined. The calculations have been extended to consider in detail the variation of flux as the incident beam is scanned across a channel axis. The results are compared with analytical estimates based on the continuum model. A strong depth oscillation is observed in the flux peak and is directly related to the crossover point of the channelled beam. The relationship between the flux enhancement and lattice location measurements is discussed. (auth)

32642 INTERACTION OF CHANNELED IONS WITH FOREIGN ATOMS IN CRYSTALS. Alexander, R. B.; Poate, J. M. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Eff.; 12: No. 3-4, 211-17(Feb 1972).

Quantitative interpretation of channeling experiments for the location of foreign atoms in a crystal depends on the interaction of channeled ions with substitutional and interstitial atoms, respectively. The interaction with substitutional atoms was investigated experimentally, using a solid solution of ~2 at. % Au in a Cu single crystal. In an angular scan across the ⟨110⟩ axis, the angular dependence of the backscattered yield from the Au atoms is found to be identical to that from the Cu atoms. For interstitial atoms, the interaction yield is known to depend on the flux peaking for a channeled beam. This was studied by computer simulations of ^{4}He channeling in the ⟨110⟩ direction in Cu. The dependence of flux peaking on depth in the crystal and the incident ion energy was investigated, and the variation with angle of incidence of the flux at different interstitial sites calculated. It is found that the normalized width and position of any peak (or dip) in an angular scan are more useful than the peak height in determining the location of interstitial atoms. (auth)

32643 USE OF THE CHANNELING TECHNIQUE TO LOCATE INTERSTITIAL IMPURITIES. Andersen, J. U. (Univ. of Aarhus, Denmark); Laegsgaard, E.; Feldman, L. C. Radiat. Eff.; 12: No. 3-4, 219-23(Feb 1972).

The channeling technique was used to locate ^{11}B implanted into various crystals. In some cases, notably in tungsten and iron, a well-defined interstitial position is indicated. The main object was to learn how to extract information about the location of an interstitial impurity from channeling measurements. It appears that sufficient evidence may be obtained only from full angular scans through different axial and planar channeling dips (or peaks). (auth)

32644 COMPUTER SIMULATIONS OF PARTICLE FLUX AND ENERGY PEAKING. Carstanjen, H. D.; Sizmann, R. (New York Univ., N. Y.). Radiat. Edd.; 12: No. 3-4, 225-31 (Feb 1972).

A computer simulation of the channeling of 300-keV deuterons in a niobium lattice was performed. The model calculations included: binary Thomas–Fermi interaction between projectiles and lattice atoms, thermal displacements of the lattice atoms in the transverse plane of particle motion, electron scattering of the deuterons dependent on the local electron density, and electronic energy loss dependent on the local electron density. Flux distributions and mean particle energy distributions of the deuterons were calculated in their development with penetration depth. Flux peaking and energy peaking were found to depend sensitively on the local variation of the electron density in the crystal. (auth)

32645 EXPERIMENTAL INVESTIGATION OF THE ENERGY AND DEPTH DEPENDENCE OF FLUX PEAKING. Eisen, F. H.; Uggerhoej, E. (Univ. of Aarhus, Denmark). Radiat. Eff.; 12: No. 3-4, 233-40(Feb 1972).

The yield of helium ions backscattered from Yb implanted in silicon crystals was studied as a function of the angle between the incident beam direction and various symmetry axes of the silicon crystal. The depth of the implanted Yb was varied by using different implantation energies, and the analyzing beam energy was varied from 0.5 to 2 MeV in an effort to obtain information about the energy and depth dependence of the flux-peaking phenomenon. The results are compared with those of Andersen (1971) and coworkers. The oscillation with depth of the flux in the center of a channel predicted by Van Vliet (1971) was observed. (UK)

32646 SURFACE STRUCTURE OF ICE STUDIED BY PROTON CHANNELING. Huber, H.; Jaccard, C.; Roulet, M. (Univ., Neuchatel, Switzerland). Radiat. Eff.; 12: No. 3-4, 241-5(Feb 1972).

Channeling of 100-keV protons along the c-axis in ice was measured in 150° backscattering between –165 and –60°C with an energy resolution of 5 keV (FWHM), corresponding to a depth resolution of 250 Å. A clean surface, with a disorder extending to less than 3 molecular diameters, is obtained above –75°C by evaporation with a rate of 400 Å/sec or more. The critical angle (half width of the scattering yield dip at half depth) is 0.8° and near the surface the minimum yield for an aligned proton beam is (11 ± 1)%. These results can be explained by Lindhard's theory, but the large thermal motion of the hydrogen nuclei reduces the atom correlation along the rows and increases the minimum yield. Below –110°C and without evaporation, radiation damage occurs in the bulk, while channeled irradiation produces a disordered layer near the surface. This layer is eliminated by sputtering with random irradiation. Water vapor deposition was identified at –157°C by analysis of the energy spectrum with implanted Xe ions. It produces a disordered structure, without correlation with the substrate. (auth)

32647 DECHANNELING OF MeV PROTONS IN TUNGSTEN. Davies, J. A.; Howe, L. M.; Marsden, D. A.; Whitton, J. L. (Chalk River Nuclear Labs., Ont.). Radiat. Eff.; 12: No. 3-4, 247-53(Feb 1972).

A systematic investigation of the dechanneling of protons in tungsten was completed for the ⟨111⟩ axial direction and also for the (110) plane. Measurements at room temperature were made at energies of 0.5, 2.0, 3.5, 8.0 and 12.0 MeV; at 2.0 MeV, the effect of target temperature was investigated over the range 77 to 873°K. In the axial case, the dechanneling rate increases strongly with the vibrational amplitude ρ, but not as strongly as the ρ^2 dependence reported previously for silicon and germanium. Also, unlike silicon and germanium, the tungsten axial data exhibit practically no energy dependence and so cannot be fitted by the $z\rho^2/E$ scaling parameter previously suggested. On the other hand, the planar dechanneling data in tungsten exhibit the predicted (E^{-1}) dependence and relatively little temperature dependence, in good agreement with previous work. (auth)

32648 DECHANNELING OF H AND He IONS IN SILICON. Fontell, A.; Arminen, E.; Leminen, E. (Univ. of Helsinki). Radiat. Eff.; 12: No. 3-4, 255-60(Feb 1972).

Dechanneling of protons and helium ions in silicon crystals was investigated with the backscattering method. The energy spectra of the scattered particles were measured using an annular surface-barrier detector. The bombardment energies E_1 were 0.6, 1.0, and 1.5 MeV. Dechanneling in the ⟨110⟩, ⟨111⟩, and ⟨211⟩ channels was measured at 298 and 473°K. The random fraction of the beam vs penetration depth was obtained by comparing the backscattering yields for aligned and random orientations of the silicon crystal. It was found that by scaling the axial penetration depth, z, with $z\rho^2$ or with z/E_1 it was not possible to make the dechanneling curves measured at different temperatures or with different energies coincide. (auth)

32649 CALCULATIONS ON AXIAL DECHANNELING. Bonderup, E.; Esbensen, H.; Andersen, J. U.; Schioett, H. E. (Univ. of Aarhus, Denmark). Radiat. Eff.; 12: No. 3-4, 261-6(Feb 1972).

An integral equation governing the change with depth of the distribution in transverse energy for an aligned beam is derived. The integral equation is approximated by a diffusion-like equation, in which the diffusion function depends on transverse energy. Thermal vibrations and scattering by electrons contribute to the diffusion. From the transverse energy distribution, the yield vs depth of close-encounter processes is evaluated. The primary aim in obtaining numerical solutions to the diffusion equation is to check the validity of simple analytical yield calculations in which diffusion is neglected. (auth)

32650 CALCULATIONS ON DECHANNELING OF PROTONS IN Si AND W. Bjoerkqvist, K.; Cartling, B.; Domeij, B. (Research Inst. for Physics, Stockholm). Radiat. Eff.; 12: No. 3-4, 267-76(Feb 1972).

Dechanneling, i.e., transition of particles from the aligned beam to the random beam, is in a faultless crystal mainly caused by two processes, scattering by thermally vibrating nuclei and by electrons. This leads to an increase in the transverse energy of the channeled particle with penetration depth, while the energy loss of the particle implies a small decrease of the transverse energy. Finally, the transverse energy will reach a certain critical value and the particle will be dechanneled. Starting from Lindhard's (1965) description of the scattering of channeled particles, the decrease of the channeled fraction was calculated as a function of penetration depth for protons in Si and W in the case of incidence parallel with a major axis. Two different expressions for the electronic scattering were tried. Attempts were made to take into account the effects of beam divergence, scattering in the surface oxide, and the energy dependence of the scattering of the particle during penetration. Comparison is made with experimental results from backscattering measurements. (auth)

32651 ELECTRON-IRRADIATION EFFECTS IN MAGNESIUM. O'Neal, T. N.; Chaplin, R. L. (Clemson Univ., S. C.). Phys. Rev., B; 5: No. 10, 3810-16(15 May 1972).

Damage-rate data for electron-irradiated magnesium samples at 4.2°K were obtained and analyzed. Since thermally activated recovery occurs at the irradiation temperature, a technique is given which corrects the data for this partial recovery. The corrected damage-rate data are compared with theoretical cross-section calculations involving several probability-of-displacement functions. The isochronal-annealing recovery spectrum is given and is explained in terms of the simultaneous recovery of several close-pair recovery processes. (auth)

32652 OPTICAL ABSORPTION AND THERMOLUMINESCENCE OF X-RAY-IRRADIATED KBr CRYSTALS AT ROOM TEMPERATURE. Hageseth, G. T. (Univ. of North Carolina, Greensboro). Phys. Rev., B; 5: No. 10, 4060-4(15 May 1972).

Two thermoluminescence peaks are observed in KBr crystals x-irradiated at room temperature. The 185°C peak can be removed by annealing the crystal for several hours at 400°C and is attributed to highly localized defects. The 152°C peak is proposed to be due to the liberation and recombination of the electrons from the F centers. The single glow peak obtained at 152°C is analyzed by the area and initial-rise methods to give thermal trap depths of 0.55 ± 0.04 and 0.61 ± 0.02 eV, respectively. The optical absorption measurements indicate that F and V_2 centers are formed in the crystal during the x-irradiation process. The thermoluminescence spectra were analyzed to consist of one narrow emission band centered at 3.08 eV. This thermoluminescence process is found to be nearly first order and an energy-level diagram is proposed to correlate the optical absorption and emission spectra. (auth)

32653 ^{17}O HYPERFINE STRUCTURE OF THE NEUTRAL (S = 1) VACANCY-OXYGEN CENTER IN ION-IMPLANTED SILICON. Brower, K. K. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., B; 5: No. 11, 4274-80(1 Jun 1972).

The intensity of the ^{17}O hyperfine spectrum associated with the ^{28}Si$-^{17}$O$-^{28}$Si isotopic configuration of the vacancy-oxygen (Si–Si) center was enhanced by ion implantation of ^{17}O into silicon. The Si–Si ^{17}O hyperfine spectrum was measured by electron paramagnetic resonance. An analysis of the Si–Si ^{17}O hyperfine spectrum indicates that the numerical values for the elements in the ^{17}O hyperfine coupling tensor $\overleftrightarrow{A}$ are $A_{xx} = -11.51 \times 10^{-4}$ cm^{-1}, $A_{yy} = -12.90 \times 10^{-4}$ cm^{-1}, and $A_{zz} = -13.39 \times 10^{-4}$ cm^{-1}. The ^{17}O hyperfine coupling tensor was analyzed in terms of the admixture of oxygen-valence orbitals into the one-electron paramagnetic molecular orbitals $\chi_1(\Gamma_1)$ and $\chi_4(\Gamma_4)$. In particular, only 4.1% of $\langle\chi_1(\Gamma_1)|\chi_1(\Gamma_1)\rangle$ and 1.8% of $\langle\chi_4(\Gamma_4)|\chi_4(\Gamma_4)\rangle$ are localized on the oxygen atom in this defect. (auth)

Physical Properties

Refer also to abstracts 30650, 30893, 30894, 30944, 31437, 31441, 31480, 31495, 31535, 31551, 31553, 31958, 32601, 32625, and 32727.

32654 (CEA-CONF-1953) GROUP REPORT ON MAGNETIC STRUCTURE WORK AT THE GRENOBLE NUCLEAR CENTER. Bertaut, E. F.; Boller, H.; Burlet, P.; Burlet, P.; Chevalier, R.; Do Dinh, C.; Kallel, A.; Rossat-Mignod, J.; Tcheou, F.; Fruchart, D.; Fruchart, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1971]. 22p. (CONF-711108-14). Dep. NTIS (U. S. Sales Only).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The following topics are discussed: magnetic moment orientations of rare earths in low symmetry sites; magnetic structure of CrAs; magnetic structures of metallic manganese perovskites; magnetic interactions in Mn and Fe formates dihydrates; and fine-particle effects in solid solutions $Ba(Fe_xAl_{1-x})_2O_4$. (auth)

32655 (EUR-4769) THEORY OF BANDS AND DYNAMICAL SCATTERING OF PARTICLES BY LARGE CRYSTALS. Blaesser, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1972. 18p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 50.-.

Well-known expressions of the dynamical scattering theory are derived by the analogy with the mathematical similar situation of the propagation of electrons in a periodic potential. It is hoped that this similarity between the theory of electron bands and the theory of dynamical scattering can be used for the discussion of more complicated problems (for example: the dynamical scattering in the presence of impurities). (auth)

32656 (IS-Trans-88) ELECTRONIC STRUCTURE OF SOME BORIDES OF TRANSITION ELEMENTS. Cadeville, M. C.; Daniel, E. Translated for Ames Lab., Iowa, from J. Phys. (Paris); 27: No. 7-8, 449-57(1966). 25p. Dep. NTIS.

There is a strong analogy between the magnetic properties (magnetizations, Curie points, and susceptibilities) and the residual resistivities of borides of general formula $M_{1-x}M'_xB$ and $(M_{1-x}M'_x)_2B$, where M and M' are metals of the first transition series, and those of the metallic alloys $M_{1-x}M'_x$. This shows that a partially filled d-type narrow band is of peculiar importance in the chemical binding of these compounds. The residual resistivities of the mixed borides for which x ≪ 1 are theoretically related to their magnetic behavior through the occurrence of virtual bound states. (auth)

32657 GRUENEISEN CONSTANT OF SOME RARE-EARTH ELEMENTS. Aggarwal, M. D.; Verma, J. K. D. (Saha Inst. of Nuclear Physics, Calcutta). Physica; 58: No. 2, 327-8(15 Ma Mar 1972).

The average value of the Grueneisen constant for some rare-earth elements was evaluated from a log (Debye temperature) versus log (atomic volume) plot. This value is in fairly good agreement with that obtained from other methods. (auth)

32658 EFFECTS OF POINT DEFECTS ON ELASTIC PRECURSOR DECAY IN LiF. Asay, J. R. (Sandia Labs., Albuquerque, N. Mex.); Fowles, G. R.; Durall, G. E.; Miles, M. H.; Tinder, R. F. J. Appl. Phys.; 43: No. 5, 2132-45(May 1972).

Experimental data for shock propagation along a ⟨100⟩ direction in single-crystal LiF show that elastic precursor decay is critically dependent on the origin of the sample. The most obvious differences among samples used are in their concentrations of impurities. It is suggested that divalent cation impurities are responsible for variations in precursor decay, and this is supported by results from a set of samples irradiated with γ rays to produce F centers. For the observed range of defect concentrations, quasistatic yield stresses varied monotonically with concentration from 0.02 kbar for pure crystals to 1.0 kbar for the hardest material studied. In the shock loading experiments both hard and soft crystals showed an initial rapid decay of the precursor to near-equilibrium values of about 2 kbar for the softest crystals and about 6 kbar for the hardest. For crystals of intermediate hardness the decay was much slower. From observed effects of annealing before shocking it is inferred that dislocation mechanisms in shock differ from those believed to operate at low strain rates. Impact stress for all experiments was about 28.6 kbar and sample thicknesses ranged from 0.27 to 15.44 mm. (auth)

32659 DIELECTRIC RELAXATION IN CRYSTALLINE V_2O_5. Mar, Kenneth Mow. Corvallis, Oreg.; Oregon State Univ. (1972). 118p. University Microfilms Order No. 72-12,523.

Thesis.

Large, plate-like crystals of vanadium pentoxide were grown under air atmosphere from the melt. The part of crystal used for measurements had a high degree of single crystallinity, with at most a ± 4° of misorientation in its layers. These crystals were prepared into three-terminal parallel-plate capacitors whose conductance and capacitance were measured simultaneously in the temperature and frequency ranges of 79 to 200°K and 10^2 to 10^4 Hz, respectively. These electrical measurements indicate the presence of the Debye-type of dielectric loss. The relaxation times, $\tau(T)$, were deduced, and the activation energy for the dipolar reorientation, H, was determined by either the shift or the half-width method. Averaging over four crystals, the values of H and τ_0 were 0.24 ± 0.03 eV and 1.1×10^{-12} sec respectively. Three different possible relaxation processes were considered, and the most probable one was concluded to be the hopping of a trapped electron around a defect in a donor center. Based on ESR, two models of dipolar centers, having oxide-ion vacancy or univalent interstitial impurity ion as defect, were proposed. The process and the energy of dipolar reorientation for these models were explained in terms of the small polaron theory. (TSS) (Diss. Abstr. Int., B)

32660 PIEZORESISTANCE EFFECTS IN CALCIUM AND YTTERBIUM. MacDonald, Douglas B. Syracuse, N. Y.; Syracuse Univ. (1971). 97p. University Microfilms Order No. 72-12,926.

Thesis.

An investigation was made of the temperature and uniaxial stress dependence of the conductivity and Hall effect in two narrow-gap semimetals, Yb and Ca, in order to search for the existence of an excitonic insulator phase, and to investigate the pressure dependence of the conduction process in these materials. The resistance of the semimetals is extremely low, with typical resistances of 10 μΩ. The apparatus used was capable of recording resistance changes of one part per million. A novel method for low-temperature thermometry resulted from this work. Bridgman found the conductivity of calcium to be abnormally pressure dependent. His experiments were of a hydrostatic nature and limited to temperatures between 0 and 100°C. These measurements were extended to temperatures as low as 1.2°K and the Hall effect measured as a function of pressure and temperature as well. The piezoresistance coefficients of Ca and Yb were measured using parallel and shear uniaxial stress in polycrystalline material. From a temperature analysis of these coefficients and other data, a better picture of the fundamental mechanisms involved in conduction and their relation to the electronic band structure was obtained. (Diss. Abstr. Int., B)

32661 MAGNETIC STUDIES OF SOME COMPOUNDS IN THE Gd–Si SYSTEM. Kugimiya, Koichi. Austin, Tex.; Univ. of Texas (1971). 122p. University Microfilms Order No. 72-11,368.

Thesis.

A compound Gd_5Si_3, reported to be ferromagnetic with a transition temperature of 280°K and a Weiss temperature of 205°K, was found to be antiferromagnetic with a Neél temperature of 62°K and a Weiss temperature of 97°K. Gd_5Si_3 specimens prepared by previous researchers contained a small amount of the ferromagnetic impurity Gd_5Si_4. The apparent loss of gadolinium metal in the preparation of specimens leads to the inclusion of Gd_5Si_4. This loss was traced to the widely used technique of arc-melting the constitutent materials. Reduction of Gd_5Si_3 to GdSi just by prolonged vaporization of melt under high vacuum led to the conclusion that in the gadolinium-rich side, the vapor pressure of gadolinium is higher than that of silicon and that the composition of Gd–Si is probably an azeotropic mixture. Measurements of the magnetic susceptibility and/or the magnetic moment of Gd_5Si_4 and GdSi compounds were also studied. It was confirmed that Gd_5Si_4 was ferromagnetic and GdSi was antiferromagnetic. (TSS) (Diss. Abstr. Int., B)

32662 HIGH PRESSURE EQUATION OF STATE OF TANTALUM, POLYSTYRENE, AND CARBON PHENOLIC DETERMINED FROM ULTRASONIC VELOCITIES. Lamberson, Donald Leslie. Wright-Patterson AFB, Ohio; Air Force Inst. of Tech. (1969). 220p. University Microfilms Order No. 72-12,905.

Thesis.

The equation of state of tantalum, polystyrene, and the composite material, carbon phenolic, was determined from experimental measurement of the ultrasonic velocities as functions of pressure and temperature. Hydrostatic pressures ranged to 150,000 psi for each material while temperatures ranged from ambient to 100°C. Calculation of the pressure dependence of the bulk modulus from the ultrasonic data allowed specification of the equation of state. The linear dependence of the bulk modulus in tantalum to 10 kbar permitted use of the Murnaghan formulation of the equation of state. However, the nonlinear pressure dependence of the bulk modulus of polystyrene and carbon phenolic required the higher-order treatment provided by the Birch equation of state. Furthermore, the transverse isotropy of carbon phenolic required the inclusion of tensorial properties. Comparison of the results with dynamic shock-wave experiments on similar materials shows good agreement at pressures very much higher than the 10 kbar available for ultrasonic measurements. The ultrasonic equations of state appear quite reasonable at pressures of about 150 kbar for polystyrene and carbon phenolic and over 2 Mbar for tantalum, which are pressure extrapolations of 1 and 2 orders of magnitude, respectively. (Diss. Abstr. Int., B)

32663 MAGNETIC PROPERTIES OF RARE EARTH–INDIUM COMPOUNDS. Shimada, Yutaka. Durham, N. C.; Duke Univ. (1971). 122p. University Microfilms Order No. 72-11,128.

Thesis.

The results of a theoretical and experimental study of the magnetic properties of five compounds of the $ReIn_3$ series are described. These compounds have cubic structures of the $AuCu_3$-type with lattice constants of 4.6736, 4.6541, 4.6213, 4.6126, and 4.5783 Å for $PrIn_3$, $NdIn_3$, $SmIn_3$, $GdIn_3$, and $DyIn_3$, respectively. Susceptibilities were measured with a highly sensitive Faraday balance at temperatures between 5.25 and 300°K. The susceptibility versus temperature data for $NdIn_3$, $SmIn_3$, $GdIn_3$, and $DyIn_3$ indicates antiferromagnetic order at low temperatures with Neél points of 7.8, 15.3, 46.0, and 21.1°K, respectively. In the case of $PrIn_3$, a negative paramagnetic Curie temperature was observed which may be indicative of antiferromagnetic order; however, anomalous behavior at low temperatures, further obscured by crystal-field effects, makes interpretation difficult. Calculations of the crystal-field splitting for the Pr^{3+} ions are described and the energy-level pattern is given. Relationships between molecular field theory and the RKKY model are derived for the case of a two sublattice antiferromagnet, which makes it possible to estimate numerically the s-f exchange constants from the susceptibility data. The calculated values of $|J(0)|$ appear reasonable. (TSS) (Diss. Abstr. Int., B)

32664 PROPERTIES AND USE OF MIS STRUCTURES. International Conference Held at Grenoble, France, June 17–20, 1969. Borel, Joseph (ed.). Grenoble, France; Centre d'Etudes Nucleaires (1969). 826p. (In French and English). (CONF-690640).

Separate abstracts were prepared for 7 of the 50 papers presented. One paper was previously included in NSA (24: 33978), and the remaining 42 papers were not within the subject scope of NSA. (W.H.K.)

For abstracts of individual papers see: 30649, 30650, and 31170–31174.

32665 MAGNETIC RESONANCE AND RELATED PHENOMENA. Proceedings of the XVIth CONGRESS A.M.P.E.R.E., Bucharest, 1–5 September 1970. Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971). 1218p. (In French and English). (CONF-700960).

A total of 256 papers are included in this volume (many in abstract or short summary form) from 23 sessions. A separate abstract was prepared for each of 22 full-length papers considered in scope for NSA. (D.L.C.)

For abstracts of individual papers see: 30771, 30816–30820, 31966, 32278, 32347, 32612–32618, and 32728–32733.

32666 STACKING FAULTS AND TWINS IN NONSTOICHIOMETRIC MoC. Mahajan, S.; Evans, J. H.; Wilyman, P. (Atomic Energy Research Establishment, Harwell, Eng.). J. Amer. Ceram. Soc.; 55: No. 3, 174-5(Mar 1972).

The crystallography of planar features observed in carburized Mo foils 0.015-mm thick was studied. The carburized samples were also examined by x-ray diffraction. The observed lines could be indexed in terms of $\alpha (\alpha = 4.28$ Å) and η ($\alpha = 3.00$ and $c = 14.58$ Å) phases, the high- and low-temperature modifications, respectively. On the basis of single-surface trace analysis, it is suggested that the habit planes of faults or fault-clusters F_1, F_2, F_3, and F_8 are probably $(\bar{1}\bar{1}1)$ and (111), whereas the traces of F_4, F_5, F_6, F_7, and F_9 are compatible with the $(1\bar{1}1)$ and $(\bar{1}11)$ planes. It is suggested that the observed planar features are precursors of the $\alpha \rightarrow \eta$ transformation according to the following dissociation: $\alpha-MoC_{1-x}(fcc) \rightarrow \eta-MoC_{1-x}(hcp) + C$. (P.C.H.)

32667 GIANT ROOM-TEMPERATURE MAGNETOSTRICTIONS IN $TbFe_2$ AND $DyFe_2$. Clark, A. E.; Belson, H. S. (Naval Ordnance Lab., Silver Spring, Md.). Phys. Rev., B; 5: No. 9, 3642-5(1 May 1972).

Huge magnetically induced strains (~0.2%) were observed in cubic $TbFe_2$ at room temperature. An anomalous "positive" temperature dependence for the magnetostriction was found for $DyFe_2$, yielding a peak in the magnetostriction exceeding 600×10^{-6} above room temperature. The source of the magnetostriction was the large strain-dependent anisotropy of the rare-earth ion situated at the cubic sites in the RFe_2 lattice. The magneto-elastic energy of the rare-earth ions in these compounds was estimated to be 2 to 5 times larger than that of the rare-earth elements themselves. (auth)

32668 MICROWAVE MAGNETIC-TRANSMISSION RESONANCE IN GADOLINIUM. Alexandrakis, George C. (Princeton Univ., N. J.); Carver, Thomas R.; Horan, Owen. Phys. Rev., B; 5: No. 9, 3472-81(1 May 1972).

Transmission-resonance experiments are described in paramagnetic and ferromagnetic gadolinium with a Curie point $T_C \cong 289$°K. Using the spin-transmission-resonance technique, it was found that transmission resonance occurs not by diffusion of spins, but by modulation of the microwave penetration depth under resonance conditions. The effect is related to "antiresonance" previously observed in some cases of ferromagnetic resonance, but is much more pronounced in the transmission technique. A simple theory, due to VanderVen, and the solution of the boundary-value problem, due to Alexandrakis, accurately describe the results for paramagnetic gadolinium, and the fitted data yield several experimental parameters, in particular the relaxation time, as well as the susceptibility and resistivity. However, preliminary results indicated that these theories are inadequate to describe the transmission signals in ferromagnetic cases, even though they are adequate to fit the conventional absorption-resonance signals. (auth)

32669 THERMODYNAMIC THEORY OF THE PHASE DIAGRAM OF MIXED TRANSITION-METAL OXIDES. Alascio, B.; Gruenfeld, V.; Lopez, Arturo (Univ. National de Cuyo, Bariloche, Argentina). Phys. Rev., B; 5: No. 9, 3708-14(1 May 1972).

The model of Falicov and Kimball for metal–insulator transitions is extended to include two types of localized states and the effect of spin–spin interactions. This allows for the description of the phase diagrams of mixed transition-metal oxides of the type $(V_{1-x}Cr_x)_2O_3$. (auth)

32670 INSULATOR–METAL TRANSITION AND LONG-RANGE MAGNETIC ORDER IN EuO. Penney, T.; Shafer, M. W.; Torrance, J. B. (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev., B; 5: No. 9, 3669-74(1 May 1972).

Several aspects of the insulator–metal transition below the magnetic-ordering temperature in EuO have been examined. The conductivity above 50°K was found to be thermally activated, with an activation energy that depends linearly on the long-range magnetic order. Below 50°K the conductivity was metallic. This insulator–metal transition was observed only in samples that were slightly oxygen-deficient, presumably in the form of vacancies. The magnitude of the exchange interaction between the conduction electron and localized spins was found to be about 0.1 eV. (auth)

32671 QUANTUM-MECHANICAL TREATMENT OF THE ABNORMAL STOPPING POWER FOR CHANNELING. Kitagawa, M.; Ohtsuki, Y. H. (Waseda Univ., Tokyo). Phys. Rev., B; 5: No. 9, 3418-21(1 May 1972).

A quantum-mechanical method for calculation of the abnormal stopping power of ion channeling is proposed. It is concluded that the abnormal stopping power is not proportional to the local electron density. Numerical calculations are performed for 3-MeV He ions in the Au crystal. (auth)

32672 ELECTROPHYSICAL PROPERTIES OF TITANIUM DIBORIDE AND ALLOYS IN THE SYSTEM Ti–B–N. Aivazov, M. I.; Domashnev, I. A. (Inst. of New Chemical Problems, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 10, 1551-3(Oct 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 10, 1735-8(Oct 1971).

The electric conductivity, thermo-emf, and Hall effect were investigated in a wide range of temperatures at different degrees of filling of the zone, observed in compositions from the homogeneous phase of TiB_2 and in alloys of the system Ti–B–N with an AlB_2 structure. The electric conductivity and thermo-emf were investigated at 300 to 1500°K, and the Hall effect at 300 to 1100°K. Results showed that the change in conductivity of these compositions was the same. The conductivity fell with increasing temperature. The temperature dependence of α and R_H for $TiB_{2.14}$ and $TiB_{2.28}$ were similar. For these compositions the thermo-emf increased with temperature, but R_H remained almost constant from room temperature to 850°K, above which a slight fall was observed. In the temperature range investigated, $\alpha(T)$ for $TiB_{1.94}$ passed through a maximum and R_H fell with increasing temperature. It was concluded that the properties may be explained satisfactorily, utilizing a scheme of overlapping zones. (P.C.H.)

32673 MAGNETISM AND MAGNETIC MATERIALS, 1971. PART I. Seventeenth Annual Conference Held at Chicago, Illinois, November 16–19, 1971. Graham, C. D. Jr.; Rhyne, J. J. (eds.). AIP Conference Proceedings, Number 5. New York; American Institute of Physics (1972). 813p. (CONF-711108–(Pt.1)).

This volume includes 115 complete papers and 24 abstracts of papers presented. The papers are grouped under the following section titles: technologies for the memory hierarchy; bubble domains—physics and materials; bubble materials—garnet films; bubble physics—stability, dynamics, and anisotropy; bubble devices; magneto-optics and spectroscopy; magnetic structural transitions; Raman scattering; Ising and Heisenberg models; nuclear magnetic resonance; one-dimensional systems; transition metals (I and II); magnetism in metals; transition-metal halides; mostly garnets; recording and memory; and magnetic recording. A separate abstract was prepared for each of 6 papers in scope for NSA. Six papers have appeared previously; see NSA Vol. 26, abstract Nos. 6437, 8615, 8618, 8619, 13,458, and 17,200. (D.L.C.)

For abstracts of individual papers see: 32674–32679.

32674 RESISTIVITY AND SPECIFIC HEAT OF FERROMAGNETIC Sc_3In. Knapp, G. S.; Isaacs, L. L.; Culbert, H. V.; Conner, R. A. (Argonne National Lab., Ill.). pp 467-71 of Magnetism and Magnetic Materials, 1971. Pt. I. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The resistivity, longitudinal magnetoresistivity, and specific heat of the itinerant ferromagnetic Sc_3In were measured between 0.5 and 19°K. These measurements show two transitions in Sc_3In, one below 2°K and the other at 5.6°K. We also determine that the density of states of Sc_3In is 1.9 ± 0.6 states $(eV\text{-}Sc\ atom)^{-1}$ and that the magnetic entropy associated with the transition is $0.02 \pm 0.01\ N_{Sc}k_B\ln 2$. (auth)

32675 SPECIFIC HEAT OF Au_4V AND Au_4Ti. Yessik, M.; Shinozaki, S. S. (Ford Motor Co., Dearborn, Mich.). pp 498-502 of Magnetism and Magnetic Materials, 1971. Pt. I. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

Measurements of the specific heat over the temperature range 1.5 to 100°K were made on samples of Au_4V in both the ordered state (ferromagnetic) and the disordered state (nonmagnetic) and of Au_4Ti in the ordered state (nonmagnetic). The electronic contribution to the specific heat of Au_4V is strongly dependent on the degree of order and the value of γ varies from 6.1 to 13.3 mJ/°K²/g-mole from the disordered to the ordered sample. The lattice contribution to the specific heat of ordered Au_4V was estimated by assuming the Debye temperature to vary with temperature in the same way as for disordered Au_4V and Au_4Ti. The magnetic specific heat was then separated from the total and the magnetic entropy calculated to be 0.28 R. This is shown to be consistent with model in which each V atom has a local moment of 1 μ_B. (auth)

32676 SHORT RANGE ORDER IN Au_4V. Asik, J. R. (Ford Motor Co., Dearborn, Mich.); Gambino, R. J.; McGuire, T. R. pp 503-7 of Magnetism and Magnetic Materials, 1971. Pt. I. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

A study was made of the short-range order (SRO) kinetics of the order–disorder transformation (ODT) in Au_4V. The time-dependent susceptibility produced by a rapid change in temperature was measured. A rapid initial increase in χ was found in which approximately 46% of the final susceptibility is achieved 10 min after a temperature jump to a region between 700 and 800°K. XRDF studies indicate no existence of the ordered BCT phase. Thus, this state is believed to be SRO in which a known fraction of V atoms are surrounded by only Au nearest neighbors. Analysis of the kinetic data indicates that the formation of SRO obeys a simple first-order rate equation with a single relaxation time τ. The temperature dependence of τ can be described by the equation $\tau = \tau_0 e^{E_m/kT}$, where E_m, the activation energy of vacancy migration, is found to be 0.47 eV. The average magnetocrystalline anisotropy constant increases appreciably with the degree of SRO. (auth)

32677 EQUATION OF STATE FOR THE KONDO SYSTEM La:Ce. Edelstein, A. S. (Univ. of Illinois, Chicago. Argonne National Lab., Ill.); Windmiller, L. R.; Ketterson, J. B.; Culbert, H. V. pp 558-74 of Magnetism and Magnetic Materials, 1971. Pt. I. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

Susceptibility measurements on the Kondo alloy La : Ce show that $\chi = cF(T,H)$ for 1.3°K ≤ T ≤ 300°K, c ≤ 15 at. %, H ≤ 20 kG where F is independent of concentration c. At high temperatures (T > 30°K), F(T,0), like other Kondo systems, obeys a Curie–Weiss law 1/(T + 27). At low temperatures (0.6 ≤ T < 30°K), $f(T,0) \propto T^{-1/2}$. To test the sensitivity of this result to local environment and the effect of spin–orbit scattering, measurements were made on $Ce_{.01}Th_xLa_{.99-x}$ (x ≤ 0.4) alloys. These measurements show that the Ce contribution to the susceptibility, cF(T,0), is unchanged by the addition of Th. The magnetic field dependence of χ does not fit a Brillouin function. Generalizing Anderson's suggestion, a phenomenological mode is developed which assumes that the density of states $N(E) \propto (E^2 + \Delta^2)^{-1/2}$ where Δ^{-1} is a lifetime. The calculated numerical results from this model for F(T,H) are in good agreement with the experimental results. Qualitatively $F \propto (T^2 + \mu^2H^2 + \Delta^2)^{-\delta}$ where $\delta = 1/4$. The Hirschkoff et al. data on Cu : Fe also fits this form with $\delta = 1/3$ and $\Delta \propto c^2$. The value $\delta = 1/3$ does not fit the data. The importance of crystalline fields and the value of T_K will be discussed. Other work on this system is briefly reviewed. 39 references. (auth)

32678 MAGNETIC PROPERTIES OF PRASEODYMIUM. Rainford, B. D. (Imperial Coll. of Science and Tech., London). pp 591-610 of Magnetism and Magnetic Materials, 1971. Pt. I. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

Recent measurements on single crystals of praseodymium are reviewed. Susceptibility and high-field magnetization measurements were made both by conventional techniques and by neutron diffraction in an applied field. The results show that Pr is an example of an induced-moment system in which the exchange interactions are not strong enough to overcome the quenching of the magnetic moment by the crystal field. Inelastic neutron scattering experiments have yielded the dispersion relations of the elementary magnetic excitations (magnetic excitons) at low temperatures. Analysis of these measurements has allowed some crystal-field splittings and the Fourier-transformed exchange interactions to be determined precisely. The dispersion relations give the first indications of the existence of anisotropic interactions in the light rare-earth metals. An attempt is made to correlate the information from these experiments with that obtained from the magnetic heat capacity. The aim is to derive a consistent set of crystal-field and molecular-field parameters that describes the main features of the magnetic properties of praseodymium. (22 references). (auth)

32679 MAGNETISM OF METALLIC ACTINIDES. **Brodsky, M. B. (Argonne National Lab., Ill.). pp 611–29 of Magnetism and Magnetic Materials, 1971. Pt. I. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).**

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The presence of 5f electrons in the actinide metals gives rise to magnetic behavior. In the lighter actinides, U, Np, and Pu, the magnetic properties are not simple because of strong 5f–6d hybridization and because the 5f electrons are fairly well extended in space. Thus, these metals do not form static, ordered moments, but have many properties that appear to be magnetic in origin. The most striking of these properties is the resistivity–temperature behavior of pure, alpha, and beta plutonium. In the heavier actinides, local moments and long-range magnetic order seem to occur as the 5f level becomes more stable and tightly bound. Dilute alloys of actinides are found to form local-moment Kondo systems (e.g. PdNp) and spin fluctuation systems (e.g. PdPu, ThU). Many of the intermetallic compounds having the ordered, cubic NaCl, $MgCu_2$, and $AuCu_3$ structures form long-range ferro- and antiferromagnetic structures, in addition to nonordered spin systems. The shift from poorly formed magnetic moments in the pure metals to long-range order in the compounds is probably due to the reduction of 5f–6d hybridization. It is concluded that spin-fluctuation behavior is common in actinide systems and is probably the cause of the nearly magnetic behavior of the pure, lighter metals. 55 references. (auth)

32680 MAGNETISM AND MAGNETIC MATERIALS, 1971. PART II. Seventeenth Annual Conference Held at Chicago, Illinois, November 16–19, 1971. Graham, C. D. Jr.; Rhyne, J. J. (eds.). AIP Conference Proceedings, Number 5. New York; American Institute of Physics (1972). 796p. (CONF-711108–(Pt.2)).

This volume includes 130 complete papers and 15 abstracts of papers presented. These papers are grouped under the following section headings: magnetic oxides; chalcogenides (mostly rare earths); domains and magnetostatics; strong magnetic fields and environmental problems; permanent magnets — materials and applications; permanent magnets; ferromagnetic resonance in films; dilute alloys — theory and experiments; magnetic resonance; critical phenomena; itinerant ferromagnetism; spin waves; magnetic structure (I and II); rare earth metals; rare earths and actinides — metals and alloys; soft magnetic materials; and microwave devices and materials. A separate abstract was prepared for each of 28 papers in scope for NSA. Eight abstracts have appeared previously; see NSA Vol. 26, abstract nos. 947, 5641, 8617, 13,423, 14,591, 14,592, 16,795, and 24,682. One other paper, CEA-CONF-1953, by E. F. Bertaut et al. appears in this issue of NSA. (D.L.C.)

For abstracts of individual papers see: 30944, 31480, 32681–32704, 32737, and 32738.

32681 CORRELATIONS OF INFRARED ABSORPTION, CONDUCTIVITY, AND STOICHIOMETRY IN EuO: A NEW PHASE DIAGRAM. **Shafer, M. W.; Torrance, J. B.; Penney, T. (IBM Research Center, Yorktown Heights, N. Y.). pp 840–4 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).**

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The conductivity, infrared absorption, microstructure and growth parameters of EuO crystals of varying stoichiometry were correlated and used to determine a new phase diagram. (auth)

32682 MAGNON SIDE BANDS IN THE LUMINESCENCE SPECTRUM OF FERROMAGNETIC EuO. **Hulin, D. (Groupe de Physique des Solides, Paris); Benoit a la Guillaume, C.; Hanus, J. pp 850–4 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).**

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The previous $^6P_{7/2} \rightarrow {}^8S_{7/2}$ fluorescence line of divalent Eu in ferromagnetic EuO is explained in terms of side bands associated with magnons. These results are comparable to these observed in MnF_2 and $RbMnF_3$. The combined effect of atomic electric dipole moments and off-diagonal exchange interactions proposed by Tanabe, Moriya, and Sugano (Phys. Rev. Lett. 15: 1023 (1965)) gives rise to an effective electric dipole moment associated with the simultaneous decay of an exciton with the emission or absorption of a magnon. (auth)

32683 DETERMINATION OF MAGNETIC MOMENTS IN THE PRESENCE OF HIGH TEMPERATURE-INDEPENDENT PARAMAGNETISM: Pr IN CeO_2. **Tveten, A. B.; Kern, S. (Colorado State Univ., Fort Collins). pp 874–8 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).**

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The formula $\chi = C/(T + \theta)$ is often chosen to describe the temperature variation of the magnetic susceptibility of rare-earth paramagnets; a plot of χ^{-1} vs T is used to obtain C (and, hence, μ, the magnetic moment) and θ. If a large temperature-independent term, α, is present, the χ^{-1} vs T plot is no longer a straight line but a curved one. Preliminary data on $(Pr_xCe_{1-x})O_2$ shows this system exhibits a relatively large α. By plotting $(d\chi/dT)^{-1/2}$ vs T, a straight line results from which μ and θ are obtained; α is given as the intercept on the χ-axis of the χ vs $1/(T + \theta)$ graph. For example, for Pr^{4+} in $(Pr_{0.02}Ce_{0.98})O_2$, μ = 2.0 Bohr magnetons, θ = 3°K, and $\alpha = 18 \times 10^{-4}$ cgsu/mole, which differ considerably from previous evaluations of these quantities. From these results, the crystal field splittings of Pr in CeO_2 are estimated. (auth)

32684 MAGNETIC PROPERTIES OF SEVERAL MONOPNICTIDES OF NEPTUNIUM AND PLUTONIUM. **Lam, D. J. (Argonne National Lab., Ill.). pp 892–6 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).**

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The compounds NpN and PuSb order ferromagnetically with T_c equal to 100 ± 2°K and 85 ± 5°K, respectively. NpSb order antiferromagnetically at 205 ± 3°K. The ferromagnetic moment for PuSb is 0.57 μ_B. The ferromagnetic moment of NpN cannot be deduced from the present results because the sample cannot be magnetically saturated in the applied field of 11 kOe. All three compounds show magnetic anisotropy at low temperature and substantial deviation from Curie–Weiss behavior at high temperature. The effective moments derived from the linear portion of the inverse susceptibility versus temperature curves are 2.44, 2.30, and 1.0 μ_B for NpN, NpSb, and PuSb, respectively. (auth)

32685 REVIEW OF COBALT–RARE EARTH PERMANENT MAGNET ALLOYS. **Martin, D. L.; Benz, M. G. (General Electric Co., Schenectady, N. Y.). pp 970–90 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).**

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

Over the last five years a family of cobalt–rare earth permanent magnet alloys has evolved, of which Co–Sm and Co–Pr–Sm have the highest permanent magnet properties. A remarkable improvement of properties has been achieved in a relatively short period of time, e.g., the $(BH)_{max}$ energy product has increased by a factor of five, the B-coercive force by a factor of three, and the remanent magnetization B_r by a factor of two. These improvements in properties have resulted from improved processing techniques producing high-density magnets with a high degree of alignment without loss of coercivity. In this review, the influence of various processing parameters (such as alloy composition, particle alignment, sintering density, and post sintering heat treatment) on saturation, remanent magnetization, and coercive force is discussed. Improvements in these magnetic properties achieved by careful control of processing are stressed. In addition, a summary of the properties of the more promising Co–R alloys is given. 16 figures; 76 references. (auth)

32686 ANGULAR DEPENDENCE OF NUCLEATING FIELDS IN Co–RARE EARTH PARTICLES. **Becker, J. J. (General Electric Co., Schenectady, N. Y.). pp 1067–71 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).**

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The coercive force of cobalt–rare earth compounds is determined by the influence on domain boundary processes of imperfections. One means of distinguishing among various possible types is the angular dependence of the field at which a magnetization jump occurs in a single particle. In a Co_5Gd particle, a $1/\cos\theta$ dependence centering about an angle 28° from the alignment axis was observed. Analysis of the data indicates that the reversal was triggered by a bit of misoriented material pinning a wall fragment and that the nucleus is very small and causes the jump to occur in the main body of the sample. (auth)

32687 10,000-Oe B-COERCIVE FORCE MAGNET. Charles, R. J.; Martin, D. L.; Valentine, L.; Cech, R. E. (General Electric Co., Schenectady, N. Y.). pp 1072-6 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The current study outlines the importance of controlling composition and sintering temperature in optimizing the magnetic properties of Co–Pr–Sm alloys. For a final nominal composition of 62.9 wt % Co, 21.3 wt % Pr, and 15.8 wt % Sm, the following properties were attained: B-coercive force 1.01 tesla [10.1 kOe] and a $(BH)_{max}$ value of 207 kJ/m^3 [26 MGOe]. (auth)

32688 PRODUCTION OF $SmCo_5$ MAGNETS USING SINGLE PHASE SINTERING AID. Carriker, R. C.; Ludewig, G. H. (Hamilton Watch Co., Lancaster, Pa.). pp 1077-81 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

Work has begun on using a single-phase sintering aid in the liquid-phase sintering of $SmCo_5$ for permanent magnets. A single-phase Sm_3Co sintering aid was prepared by arc melting and ball milling. This powder was used as a sintering aid in the liquid-phase sintering of a nearly single-phase $SmCo_5$ powder (slight amounts of Sm_2Co_7 and $SmCo_3$ present), which was also prepared by arc melting and ball milling. The $SmCo_5$ and Sm_3Co powders were mixed to yield an approximately 38 wt % samarium blend, which was subsequently aligned and pressed in a magnetic field and then sintered. Magnetic performance was observed as a function of sintering temperature and an optimum sintering temperature was determined. The use of this single-phase sintering aid appeared to be quite promising since initial efforts produced a magnet with the following properties: $B_r = 8100$ G, $H_c = 5100$ Oe, $H_{c_i} = 12{,}100$ Oe, $(BH)_{max} = 14.0$ MGOe, and density = 8.32 g/cm^3. (auth)

32689 MAGNETIC PROPERTIES OF Pd–RARE EARTH ALLOYS. Praddaude, H. C.; Foner, S.; McNiff, E. J. Jr. (Massachusetts Inst. of Tech., Cambridge). pp 1170-3 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The magnetization of paramagnetic $Pd_{1-x}R_x$ alloys was measured up to 210 kG for $x \simeq 0.01$ and R = Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, or Lu. Except for Ce, Eu, and Lu, which have no moment, the impurity is incompletely magnetized even at highest fields and 4.2°K. The data were fitted to a semi-empirical formula, which yields the saturation moment per impurity (μ_s), the matrix susceptibility (χ_b), and a parameter (B) reflecting the ease of magnetizing the impurity. The temperature dependence of the susceptibility to $T \simeq 300$°K also was measured. It is found that: (1) μ_s and the effective moment obtained from the temperature dependent data are close to the free-ion value, (2) the ionization state is R^{3+} except for Ce and Pr for which it is R^{4+}, (3) there is no detectable magnetic polarization of the matrix by the R impurity, (4) the matrix susceptibility is smaller than that of pure Pd, (5) B appears to reflect orbital angular momentum effects, and (6) $\mu_s = 0$ for Ce, in disagreement with results previously reported. (auth)

32690 THERMOPOWER OF GADOLINIUM NEAR ITS CURIE POINT. Tang, S. H. (Brookhaven National Lab., Upton, N. Y. State Univ. of New York, Stony Brook); Cadieu, F. J.; Kitchens, T. A.; Craig, P. P. pp 1265-8 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The critical thermopower in the vicinity of T_c of single-crystal Gd along the a- and c-axes shows different temperature dependence. From the a-axis thermopower, the contribution to the specific heat of ferromagnetic ordering from charge carriers is estimated. The transport specific heat is about $^1/_{14}$th of the bulk specific heat, showing that the transport specific heat arises from the itinerant electrons, with little or no contribution from the localized 4f electrons. (auth)

32691 ELECTRONIC STRUCTURE OF $ZrZn_2$. Veal, B. (Argonne National Lab., Ill.); Mueller, F. M.; Afshar, R.; Shaffer, J. pp 1285-9 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The normal-incidence reflectivity of the weakly ferromagnetic cubic Laves-phase compound $ZrZn_2$ and a sample of the related ternary system $ZrCu_{2-x}Al_x$ was measured from 0.2 to 5 eV. Both of the samples exhibit rather similar reflectivity spectra with prominent features appearing near 0.8 and 3 eV. The data were Kramers–Kronig-analyzed and the complex dielectric function calculated. Comparison to the recent model of Koelling et al. is given. (auth)

32692 LOW-TEMPERATURE ANOMALY IN HEAT CAPACITY MEASUREMENTS OF $ZrZn_2$. Viswanathan, R.; Luo, H. L.; Massetti, D. O. (Univ. of California, San Diego, La Jolla). Contract AT(04-3)-34. pp 1290-4 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

Small heat-capacity anomalies at the Curie temperature T_c were detected in weakly ferromagnetic $ZrZn_2$ samples by the steady-state calorimetry technique. The variation in the T_c's of the samples could be accounted for by the degree of order, determined by the annealing schedules. The density of states (and hence γ) is quite high for all $ZrZn_2$ samples and it does not directly correlate with the variation in their T_c's. $\gamma \simeq 28$ mJ/gm-mole-°K^2 and $\theta_D \simeq 280$°K are expected for a completely nonmagnetic $ZrZn_2$. (auth)

32693 MAGNETIC PHASE DIAGRAM OF THE $UAs_{1-x}S_x$ SYSTEM. Lander, G. H.; Mueller, M. H.; Reddy, J. F. (Argonne National Lab., Ill.). pp 1371-5 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The magnetic phase diagram of the $UAs_{1-x}S_x$ system ($0 \le x \le 1$) was investigated by neutron diffraction with powder samples. All compositions are fcc (NaCl type). For x = 0 (UAs), the type-I antiferromagnetic ordering (T_N = 127°K) has ferromagnetic sheets stacked + – + – that change at 0.5 T_N to the type-IA ordering with the sheets stacked + + – –. This transition is accompanied by an increase in the magnetic moment from 1.9 to 2.2 μ_B per uranium atom. As x increases, the stability of the type-IA structure increases until this phase is present at all temperatures below T_N for x = 0.20. For x between 0.25 and 0.34, the magnetic moments are modulated sinusoidally from layer to layer. The repeat distances in real space vary from ~2.8 unit cells at x = 0.25 to ~4.2 unit cells at x = 0.34. The periodicity is not a function of temperature, but only of concentration x. Over a narrow composition region, near x = 0.30, the longitudinal-wave modulation is stable to 2.2°K. For x > 0.34, the samples are ferromagnetic. (auth)

32694 MAGNETIC STRUCTURE AND PROPERTIES OF THE METAMAGNET $TbCu_2$. Brun, T. O. (Argonne National Lab., Ill.); Felcher, G. P.; Kouvel, J. S. pp 1376-80 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

Neutron diffraction study of the metamagnetic compound $TbCu_2$ revealed an antiferromagnetic structure in zero field whose unit cell is equal to the orthorhombic chemical cell along b and c but tripled along a. The Tb moments in an a–c plane form a collinear configuration where $^2/_3$ of them point along +a (sublattice A) and $^1/_3$ along –a (sublattice B); in adjacent planes the moments are all reversed. Although all the Tb moments are equal (~8.9 μ_B) at 5°K, those on sublattice A decrease faster with temperature than those on B, their ratio approaching 1 : 2 near the Néel point (~54°K). The magnetic structure and the temperature dependence of the moments can be explained by molecular field theory, but only if an anisotropy comparable to the isotropic exchange is invoked. This strong anisotropy is also manifested in the metamagnetic transition. New magnetic measurements show that this transition occurs with large hysteresis at a critical field (H_c) of ~19 kOe at temperatures up to ~30°K, where the hysteresis vanishes abruptly and H_c gradually decreases. (auth)

32695 MAGNETIC STRUCTURES OF CeBi. Cable, J. W.; Koehler, W. C. (Oak Ridge National Lab., Tenn.). pp 1381-4 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

Neutron-diffraction measurements were made on CeBi to determine the type of magnetic order that develops in this metamagnetic compound. In contrast to results obtained for polycrystalline samples, these single-crystal measurements show two antiferromagnetic structures for this fcc (NaCl-type) compound. The high-temperature structure develops below 25.2°K and consists of ferromagnetic (001) layers of moments in a + − + − stacking sequence. At 12.5°K, there is a first-order transition to the low-temperature structure, which also has ferromagnetic (001) layers but in the sequence + + − −. For both structures, the moments are about 2.1 μ_B per Ce and are parallel to the c-axes of the tetragonal magnetic unit cells. (auth)

32696 MAGNETIC STRUCTURE OF RAu_2 COMPOUNDS (R = Tb TO Tm). Fedro, A. J. (Northern Illinois Univ., DeKalb. Argonne National Lab., Ill.); Shaffer, J. C. pp 1390-4 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

Neutron-diffraction experiments by Atoji on RAu_2 intermetallic compounds with R = Tb to Tm have shown that the magnetic ordering is generally characterized by a high-temperature antiferromagnetic phase with associated wavelength incommensurate with the rare-earth lattice transforming via a first-order transition to a commensurate antiferromagnetic phase at a lower temperature. In both cases, the wave propagates in the (110) direction. In contrast to the rare-earth metals, the magnetization wavelength, λ_p, at the paramagnetic transition temperature, T_p, is approximately constant independent of the particular element (Tb to Tm) while a standard plot of T_p versus $(g-1)^2J(J + 1)$ deviates significantly from a straight line. Assuming the s−f exchange interaction is responsible for the magnetic ordering, a normal Yosida and Watabe calculation in which the s−f exchange integral, J_{sf}, is treated as a constant and in which the 4f wave function is taken to have zero width, predicts only the commensurate phase as well as predicting no differences among the rare earths. If the finite and varying widths of the various 4f functions are taken into account in a manner similar to Robinson et al. for the rare-earth metals, the appropriate dispersion curves are altered in such a manner that the incommensurate state is stable at high temperatures. The introduction of anisotropy energies, such as the magnetoelastic energy or conduction band splitting, forces the system to transform to the commensurate state at lower temperatures similar to the antiferro−ferromagnetic transition in rare-earth metals. (auth)

32697 MAGNETIC PROPERTIES OF $Gd_{1-x}Th_xFe_3$. Greedan, J. E. (Univ. of Pittsburgh). pp 1425-9 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The pseudo-binary solid-solution system $Gd_{1-x}Th_xFe_3$ was investigated with respect to magnetic properties. All members of the system exhibit the $PuNi_3$-type structure. The magnetic behavior of materials in the composition range x = 0 to about x = 0.5 can be understood in terms of a collinear two-sublattice model in which the total gadolinium moment is aligned antiparallel to the total iron moment. Such a model was found to be applicable to nearly all known rare-earth−transition metal ferrimagnets. For the composition range x > 0.5 (x = 1 excluded), however, there is evidence for the existence of a noncollinear state at low field strengths (<10 kOe) below room temperature. σ(T) curves show an abrupt transition, the temperature and magnitude of which vary with composition and applied field. σ(H) curves at various temperatures up to the transition point show a pronounced step at about 11 kOe. The magnetic behavior of $ThFe_3$ is that of a typical ferromagnet with T_c = 450°K. (auth)

32698 FIELD-DEPENDENT SPIN STRUCTURE OF ERBIUM. Rhyne, J. J.; Pickart, S. J. (Naval Ordnance Lab., White Oak, Md.). pp 1436-40 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The effect of magnetic fields on the conical moment structure of erbium was investigated by neutron diffraction. The basic periodicity of the magnetic structure τ = 0.24 c* at 4°K was unaltered by fields up to 60 kOe applied along [100]. At 60 kOe a ferromagnetic (FM) component appeared in the (002) intensity, while the total moment in the plane perpendicular to [110] remained essentially equal to the zero-field value of 7.5 μ_B. Zero-field satellite intensities (002±) were reduced by a factor of 5 while the (110±) satellites were lower by more than a factor of 20 at 60 kOe. The results suggest the development of a fan structure with a fundamental (FM) component μ_0 = 3.8 μ_B along [100] and an angular width decreasing with field to 45° at 60 kOe. Such a structure contributes intensity to first-order satellites of (002) but not of (110) as observed. (auth)

32699 INTRINSIC COERCIVE FORCE IN Dy. Egami, Takeshi (Univ. of Pennsylvania, Philadelphia). pp 1457-61 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The coercive force of Dy single crystals was measured at low temperatures using both dc and ac methods to verify the predicted intrinsic coercive force. The coercive force was found to depend upon the field sweep rate, increasing monotonically with sweep rate, but reaching a maximum (intrinsic) value above a certain sweep rate. The observed intrinsic coercive force is in a good agreement with theory, both in magnitude and in temperature dependence. (auth)

32700 EFFECT OF STRESS ON THE CURIE TEMPERATURE OF GADOLINIUM FILMS. Klokholm, E.; Gambino, R. J.; Cuomo, J. J. (IBM Watson Research Center, Yorktown Heights, N. Y.). pp 1462-3 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

High-purity polycrystalline films of Gd were deposited onto oxidized silicon and sapphire wafers by rf sputtering. By varying the substrate temperatures during deposition, it was possible to vary the film stress from −6.5 kbar (compressive) to 1 kbar (tensile). The variation in T_c was linear with a slope of 1.8°C/kbar, which is in good agreement with the value reported for bulk Gd of about 1°C/kbar. (auth)

32701 COMPARISON OF ANOMALIES OBSERVED IN U- AND Ce-INTERMETALLICS. Buschow, K. H. J.; van Daal, H. J. (Philips Research Labs., Eindhoven, Netherlands). pp 1464-77 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The temperature dependence of the electric resistivity and magnetic susceptibility was investigated for the compounds UAl_2, UAl_3, and the isostructural compounds UX_3 (X = Ga, In, Si, Ge, Sn), and finally for UAl_4 and UGa_2. The influence of a variable U concentration was studied for the pseudobinary compounds $U_{1-x}Y_xAl_2$ and $U_{1-x}Y_xGa_2$. The results are discussed in terms of a localized-spin-fluctuation model. The differences and the similarities between the electrical properties of these U compounds and Ce compounds, such as $CeAl_2$ and $CeAl_3$, are briefly discussed. (auth)

32702 MAGNETIC PROPERTIES OF SOME CUBIC INTERMETALLIC COMPOUNDS OF PLUTONIUM WITH Ru, Rh, Pd, Ir, AND Pt. Nellis, W. J.; Brodsky, M. B. (Argonne National Lab., Ill.). pp 1483-7 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The magnetization of all cubic intermetallic compounds of the form PuX_2 and PuX_3, where X is a nonmagnetic Group VIII transition metal, was measured between 2.5 and 300°K. $PuRh_2$, $PuPt_2$, $PuRh_3$, $PuPd_3$, and $PuPt_3$ have effective paramagnetic moments of about 1 μ_B per formula unit. The latter three compounds order magnetically with T_N = 6.2, 24, and 59°K, respectively. $PuPt_2$ has a spontaneous moment below T_C = 6°K of about 0.2 μ_B. $PuPt_2$ is probably an itinerant ferromagnet, while localized magnetic moments are apparently well formed in $PuPt_3$. The degree of localization of electrons in the other magnetic compounds is probably intermediate to that found in these two cases. (auth)

32703 MAGNETIC ANISOTROPY OF SCANDIUM, DILUTE SCANDIUM ALLOYS, AND TECHNETIUM. Isaacs, L. L. (Argonne National Lab., Ill.); Lam, D. J.; Ross, J. W. pp 1488-92 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

Magnetic anisotropies, defined as the difference in magnetic susceptibility perpendicular to the c-axis and parallel to the c-axis, $\chi_{\perp c} - \chi_{\parallel c}$, of hcp scandium, dilute scandium-base alloys with both magnetic and nonmagnetic solutes, and high-purity technetium were studied as a function of temperature between 2 and 300°K. The magnetic anisotropy of scandium is not affected by small amounts of nonmagnetic impurities such as cerium and thorium. The anisotropy changes drastically at low temperature when scandium is alloyed with the magnetic solutes gadolinium and dysprosium. The magnetic anisotropy $\chi_{\perp c} - \chi_{\parallel c}$ changes sign from positive to negative at low temperature in the Sc–Gd alloys. The sign of $\chi_{\perp c} - \chi_{\parallel c}$ remains positive but increases by several orders of magnitude with decreasing temperature in the Sc–Dy alloys. (auth)

32704 SEMIHARD MAGNETIC ALLOYS OF Co–Fe–Ni–Nb SYSTEM. Henmi, Zenzo; Sasaki, Tatsuji; Okada, Masanori; Kassai, Makoto; Suzuki, Yuichi (Fujitsu Labs., Kawasaki, Japan). pp 1529-33 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

Ductile alloys with approximately equal amounts of Co and Fe, plus Ni and a small amount of Nb, were investigated for remanent reed-switch applications. As a result, 39Fe–38Co–20Ni–3Nb wire 0.6 mm in diameter, made by intermediate annealing at 700°C, cold drawing to 92% reduction in area, and final annealing at 600°C for 1 hour, showed a coercive force of 30 Oe, remanence of 16,000 G, squareness ratio higher than 0.95, and thermal expansion coefficient of 98×10^{-7}/°C between 30 and 400°C. This alloy could be cold worked easily after annealing. The phase was fcc after annealing at a temperature over 800°C. However, cold working caused partial phase transformation of fcc into bcc. This intermixing of fcc and bcc phases in a high-coercive force state survived up to 700°C annealing. On the other hand, remanence was low in the cold-drawn state, but increased by annealing over 600°C. The coercive force grew larger as the Nb content increased. (auth)

32705 FORMATION AND MOBILITY OF VACANCIES IN CADMIUM. Vostry, P.; Simon, J. P.; Hillairet, J. (CEN, Grenoble, France). Phys. Status Solidi (b); 50: No. 2, K75-9(1 Apr 1972). (In French).

Studies were made on the characteristics of defects retained in Cd by annealing between 0 and 200°C with electric conductivity measurements at 4.2°K. The energy of formation of some vacancies in Cd was determined. It was found that the presence of impurities, even at lower concentrations, affected the elimination of the supersaturation retained by annealing. It seemed that the agglomeration played only a secondary role in that elimination. (P.C.H.)

32706 C-AXIS CONDUCTIVITY OF PYROLYTIC GRAPHITE. Young, D. A. (Imperial Coll. of Science and Tech., London). Phys. Status Solidi (b); 50: No. 2, K143-6(1 Apr 1972).

Numerical agreement between experimental and theoretical values demonstrated for pyrolytic graphite supports the general approach to c-axis conduction in this material using localized basis functions. (P.C.H.)

32707 STRESS RELAXATION IN SOLID HYDROGEN AND DEUTERIUM. Bol'shutkin, D. N.; Stetsenko, Yu. E. pp 65-9 of Mekhanizmy Relaksatsionnykh Yavlenii v Tverdykh Telakh. /Postnikov, V. S. (ed.). Moscow; Izdatel'stvo Nauka (1972). (In Russian).

The mechanical properties and relaxation of stress of polycrystalline parahydrogen, normal hydrogen, and deuterium were investigated during uniaxial stress and temperatures down to 1.4°K. Changes in plasticity and mechanical properties are associated with rotation and molecular orientation in the crystal lattice. (tr-auth)

32708 INFLUENCE OF DISLOCATION SUBSTRUCTURE ON THE DISLOCATION RELAXATION IN MOLYBDENUM MONOCRYSTALS. Myul'bakh, G. pp 120-3 of Mekhanizmy Relaksatsionnykh Yavlenii v Tverdykh Telakh. /Postnikov, V. S. (ed.). Moscow; Izdatel'stvo Nauka (1972). (In Russian).

The effect of a dislocated substructure in monocrystals of Mo on the α peak of internal friction was examined. The crystals had previously been subjected to deformation by rolling at room temperature. (tr-auth)

32709 RELAXATION PROCESSES IN BORON. Tsagareishvili, G. V.; Metreveli, V. Sh.; Darsavelidze, G. Sh.; Tavadze, F. N. pp 143-7 of Mekhanizmy Relaksatsionnykh Yavlenii v Tverdykh Telakh. /Postnikov, V. S. (ed.). Moscow; Izdatel'stvo Nauka (1972). (In Russian).

Relaxation processes in 99.9% boron in the temperature range 80 to 1,000°K were investigated with the aid of a low-frequency relaxation oscillator and a torsion pendulum. The peaks of internal friction were analyzed, and the effect of annealing at 530°K was studied. (tr-auth)

32710 INFLUENCE OF IMPURITIES ON TEMPERATURE DEPENDENCE OF INTERNAL FRICTION OF STABILIZED ZIRCONIUM DIOXIDE. Kovalev, A. I.; Pechenezhskii, V. I. pp 156-9 of Mekhanizmy Relaksatsionnykh Yavlenii v Tverdykh Telakh. /Postnikov, V. S. (ed.). Moscow; Izdatel'stvo Nauka (1972). (In Russian).

Maxima on the thermal curves of internal friction of ZrO_2 and the effect of the presence of impurities and of a nonstabilized monoclinic phase are discussed. (tr-auth)

32711 MAGNETIC STRUCTURES OF EQUIATOMIC RARE EARTH–RHODIUM COMPOUNDS RE–Rh (RE = Dy, Ho, Er). Chamard-Bois, R.; Nguyen Van Nhung; Yakinthos, J.; Wintenberger, M. (CEN, Grenoble, France). Solid State Commun.; 10: No. 8, 685-9(15 Apr 1972). (In French).

Neutron diffraction on powdered samples showed that the antiferromagnetic structures of ErRh and HoRh may be described by a propagation vector k (0 0 ½) or by some related multiaxial configurations. The rare earth magnetic moments in these compounds and in ferromagnetic DyRh were evaluated. (auth)

32712 RANGES AND RANGE STRAGGLING OF ^{150}Sm IN COPPER AND SILVER. Cohn, Gerald Edward. Madison, Wis.; Univ. of Wisconsin (1972). 161p. University Microfilms Order No. 72-4265.

Thesis.

The ion-implantation-perturbed-angular-correlation method was applied to the determination of heavy ion ranges and range straggling. Experiments were performed on ^{150}Sm stopping in natural copper and natural silver. Three-layer targets were prepared by evaporating a layer of the stopper onto an iron backing foil and then, after the stopper thickness was measured, evaporating ^{150}Sm onto the stopper. Each target was placed in a magnetic field and was bombarded with an accelerator beam to Coulomb excite the ^{150}Sm and drive it forward into the target. Angular correlations of de-excitation gamma rays from the 2^+ first excited state of ^{150}Sm in coincidence with backscattered beam ions were observed over an energy span broad enough to include the two extreme cases of of all recoils stopping in iron and all recoils stopping in copper and silver. The observed angular correlation was assumed to be a linear superposition of the correlations for ^{150}Sm in polarized iron and ^{150}Sm in the stopper, and the fraction f of the recoils coming to rest in the stopper was computed at each energy. Plots of f versus recoil energy were used to determine range–energy and range straggling information. The ranges for the copper stoppers were found to be somewhat greater than the predictions of the Lindhard theory, while those for silver agreed with the theory. For both stopper metals, the relative straggling $\Delta R/R$ was greater than the theoretical prediction, the discrepancy being larger for silver than for copper. (Diss. Abstr. Int., B)

32713 POSITRON LIFETIMES IN OXIDES. Noguchi, Masayasu (Japan Atomic Energy Research Inst., Tokyo); Mitsuhashi, Takefumi; Chiba, Toshinobu; Tanaka, Takaho; Tsuda, Nobuo. J. Phys. Soc. Jap.; 32: No. 5, 1242-7(May 1972).

Lifetime spectra of positrons in oxides were measured. Densities of oxygen ions corrected for the ionicities are rather good parameters describing τ_1^{-1} and thus positrons may be itinerant in oxides. The annihilation rates τ_1^{-1} are about 1.5 times as large as those calculated on the assumption that the positrons distribute homogeneously. (auth)

32714 LIFETIME SPECTRA OF POSITRONS IN ZrO_2. Mitsuhashi, Takefumi (National Inst. for Researches in Inorganic Materials, Tokyo); Noguchi, Masayasu; Chiba, Toshinobu; (and others). J. Phys. Soc. Jap.; 32: No. 5, 1281-6(May 1972).

Lifetime spectra of positrons for variously prepared ZrO_2 are described essentially by a single parameter: particle size. A simple model to describe τ_1, τ_2, τ_3, and I_3 is developed. There is a discrepancy between particle size obtained by an x-ray diffraction pattern and that deduced from a lifetime spectrum for a sample at the initial stage of the crystallization. (auth)

32715 SOLUTE DIFFUSION OF GOLD AND SILVER IN FCC γ-CERIUM AND BCC δ-CERIUM. Dariel, M. P. (Nuclear Research Centre-Negev, Beer-Sheva, Israel); Dayan, D.; Calais, D. Phys. Status Solidi (a); 10: No. 1, 113-19(16 Mar 1972).

The solute diffusivities of gold and silver were measured in fcc γ- and bcc δ-cerium using the serial sectioning method. The results can be expressed as follows: In fcc γ-cerium: $D^{Au} = 4.4 \times 10^{-3} \exp(-14900/RT)$ cm^2/sec, $D^{Ag} = 2.5 \times 10^{-2} \exp(-21100/RT)$ cm^2/sec; in bcc δ-cerium: $D^{Au} = 9.5 \times 10^{-2} \exp(-20500/RT)$ cm^2/sec, $D^{Ag} = 1.2 \times 10^{-1} \exp(-22200/RT)$ cm^2/sec. Comparison with self-diffusion in cerium indicates that the solute diffusion of the noble metals takes place via a different mechanism, most likely the dissociative diffusion mechanism. (auth)

32716 ABSORPTION SPECTRUM OF Er^{3+} IONS IN CUBIC ZIRCONIA. Arashi, H. (Tohoku Univ., Sendai). Phys. Status Solidi (a); 10: No. 1, 107-12(16 Mar 1972).

Yttria-stabilized zirconia crystals doped with Er^{3+} ions were prepared from the melt using a large solar furnace. In order to investigate the oxygen-ion coordination around Y^{3+} ion using Er^{3+}

ion as a probe, the absorption spectra of the crystals were measured in the spectral region 30,000 to 4000 cm^{-1}. From the experimental results, the following characteristics were deduced: The oxygen ion coordination around Y^{3+} ion in cubic zirconia is not only eightfold but also sevenfold or sixfold, and oxygen ions deviate slightly from the fluorite-type lattice sites. Thus, the cubic zirconia does not take a perfect fluorite-type crystal structure. (auth)

32717 INELASTIC INCOHERENT NEUTRON SCATTERING FROM IMPURITIES IN CRYSTALS. Cohen, S. S. (Technion-Israel Inst. of Tech., Haifa). Phys. Status Solidi (b); 50: No. 2, 673-9(1 Apr 1972).

An extremely simple formulation of inelastic incoherent neutron scattering from impure crystals is presented. The formulation treats both mass and central-force-constant changes at the defect site in a closed form that is immediately amenable to an experimental analysis. (auth)

32718 MODIFIED CONVOLUTION APPROXIMATION MODEL FOR NEUTRON SCATTERING FROM SHORT-RANGE-ORDERED PARAMAGNETS. Rao, L. Madhav (Bhabha Atomic Research Center, Trombay, India). Phys. Status Solidi (b); 50: No. 2, 737-46(1 Apr 1972).

A modified convolution approximation model was developed to explain neutron scattering from short-range-ordered paramagnets, employing the concepts used in understanding neutron scattering of simple liquids. Calculations based on this model were compared with the following experimental results in paramagnetic MnO: (1) scattered neutron energy spectra at room temperature, using the triple-axis spectrometer; and (2) scattered neutron time-of-flight spectra at 124, 143, and 298°K. The model explains satisfactorily the narrowing of the line shape observed in (1) and also explains qualitatively the observed energy shifts in (2), at all the three temperatures without assuming spin-wave like excitations. These apparent energy shifts are explained to arise essentially from the "non-constant Q" nature of the measurements. (auth)

32719 MEASUREMENTS OF OXYGEN PRESSURE DEPENDENCE OF ELECTRICAL CONDUCTIVITY FOR $(U_yTh_{1-y}O_{2+x}$. Tanaka, Hiroshi; Kimura, Etsuji; Yamaguchi, Akio; Moriyama, Joichiro (Kyoto Univ.). J. Jap. Inst. Metals; 36: No. 3, 183-8 (Mar 1972). (In Japanese).

The oxygen pressure dependence of electric conductivity for solid solution $(U_yTh_{1-y})O_{2+x}$ was measured in the oxygen pressure range 1 to 10^{-25} atm at 699° and 882°C. Between the oxygen pressure dependence of conductivity and the mean valence of U ion in the solid solution, there existed a correlation, which was independent of the value of y. In the range of about 4.02 to 4.3 in the mean valence of U ion, the conductivity was considered to be due to a polaron hopping mechanism similar to that of UO_{2+x} proposed by Aronson et al., (J. Chem. Phys., 32: 749(1960)). (auth)

32720 INTERPRETATION OF MAGNETIC STRUCTURES OF TCo_3 COMPOUNDS (T = Pr, Nd, Tb, Ho, AND Er). Yakinthos, J.; Rossat-Mignod, J. (CEN, Grenoble, France). Phys. Status Solidi (b); 50: No. 2, 747-54(1 Apr 1972). (In French).

Neutron-diffraction studies on TCo_3 compounds showed that the magnetic moment direction depends on the particular rare earth ion as well as on its crystallographic position. The magnetic-modes analysis predicts collinear structure either in the base plane (Nd, Tb, Ho) or along the c-axis (Pr, Er). The direction of these moments is imposed by the T_I sublattice anisotropy, and is thus an intrinsic property of the rare earth ion. The direction is only determined by the sign of α in the crystal-field Hamiltonian $H_c = \alpha V_2^0[3\,J_z^2 - J\,(J+1)]$. (auth)

32721 MAGNETIC MEASUREMENTS OF CURIUM METAL, CmF_3, AND CmOCl. Marei, S. A.; Cunningham, B. B. (Univ. of California, Berkeley). J. Inorg. Nucl. Chem.; 34: No. 4, 1203-6(Apr 1972).

Magnetic susceptibility measurements of curium metal in the temperature range 145 to 550°K followed the Curie–Weiss law with an effective moment of $7.99 \pm 0.15\ \mu_B$ and showed the metallic valence to be approximately three. Similar measurements on tripositive curium compounds also followed the Curie–Weiss law in the temperature range 77 to 298°K with an effective moment of $7.65 \pm 0.10\ \mu_B$. (auth)

32722 EFFECT OF PLASTIC DEFORMATION ON ELECTRICAL RESISTANCE OF NIOBIUM–HYDROGEN ALLOYS. Sasaki, Yasuo; Matsumoto, Takehiko (National Research Inst. for Metals, Tokyo). Jap. J. Appl. Phys.; 11: No. 5, 617-22(May 1972).

The effects of plastic deformation on the electrical resistance of niobium containing 0.16, 0.35, and 1.8 at. % hydrogen were studied. The resistance of the specimens, undeformed and deformed, was measured in the temperature range, 77 K to 320 K. In the resistance of undeformed Nb–H alloy, an obvious inflection occurred at the critical temperature (T_C) of the phase transition ($\alpha \rightleftharpoons \alpha$ + hydride). The obvious inflections in Nb–0.16 and Nb–0.35 at. % H alloys were smeared out by the plastic deformation. The obvious inflection, on the other hand, was retained in the deformed Nb–1.8 at. % H alloy. These behaviors were analyzed in terms of the dependence of the solubility of hydrogen on stresses arising from the presence of dislocations. It was interpreted that hydrogen segregation into dislocation stress field is effectively induced near T_C for the specimens with lower hydrogen content, and not sufficiently for Nb–1.8 at. % H alloy showing higher T_C. (auth)

32723 SPIN FLUCTUATIONS IN PLUTONIUM AND OTHER ACTINIDE METALS AND COMPOUNDS. Arko, A. J.; Brodsky, M. B.; Nellis, W. J. (Argonne National Lab., Ill.). Phys. Rev., B; 5: No. 11, 4564-9(1 Jun 1972).

It is proposed that the anomalous behavior of the resistivities of Pu and Np and some actinide intermetallic compounds can be explained on the basis of spin fluctuations in narrow 5f bands. An initial T^2 increase is observed in the resistivities of all these systems. From radiation-damage data, there are two distinct regions of 5f-electron behavior: (i) a high-temperature region ($\gtrsim$100°K), where the 5f electrons occupy virtual bound states and the metal resembles a disordered alloy with magnetic impurities such as Pd(U), and (ii) a low-temperature region, where the 5f bands are hybridized and a well-defined Fermi surface is formed. Anomalies observed in several properties of Pu at 60°K may well reflect the temperature at which well-defined 5f bands begin to form. (27 references). (auth)

32724 INFLUENCE OF THE CRYSTALLINE FIELD ON THE KONDO EFFECT OF ALLOYS AND COMPOUNDS WITH CERIUM IMPURITIES. Cornut, B. (Centre de Recherches sur Les Tres Basses Temperatures, Grenoble, France); Coqblin, B. Phys. Rev., B; 5: No. 11, 4541-61(1 Jun 1972).

The influence of the crystalline field on the Kondo effect of alloys with cerium impurities is studied in the framework of an effective Hamiltonian which describes the resonant-scattering character of the cerium impurities and which takes into account combined spin and orbit exchange scattering. The third-order perturbation-theory resistivity is computed exactly for any configuration of levels split by the crystalline field and is especially derived for the cases of two or three levels. The model is applied to the resistivity measurements of $CeAl_2$ and $CeAl_3$ compounds and to LaCe and YCe alloys. A general discussion of the magnetic and transport properties can explain the different roles of the crystalline field and of the Kondo effect for alloys with cerium impurities especially in the case of LaCe alloys. (54 references) (auth)

Moessbauer Effects and NMR

Refer also to abstracts 30722, 30745, 30771, 30816, and 30819.

32725 (HEDL-TME-71-177) MOSSBAUER DATA ANALYSIS USING A HYBRID COMPUTER. Ord, R. Neil; Worth, Grant A. (Hanford Engineering Development Lab., Richland, Wash.). 1 Nov 1971. Contract AT(45-1)-2170. 46p. Dep. NTIS.

The Moessbauer data analysis program was developed to satisfy the needs of two problems: (a) to curve fit Moessbauer spectra having at times non-Lorentzian line shapes (for example, the 300 stainless steel series) and (b) to aid the spectroscopist in the analysis of complicated spectra having unknown constituents. This report describes the operation of the hybrid computer curve fitting program; presents several examples of Moessbauer spectra analyzed using the program; and presents a linearized least-squares technique using first order approximations from the hybrid program for Lorentzian and Gaussian line shapes. (auth)

32726 HIGH-FREQUENCY NUCLEAR MAGNETIC RESONANCE IN THULIUM INTERMETALLIC COMPOUNDS. Smith, William Conrad. Ames, Iowa; Iowa State Univ. (1971). 174p. University Microfilms Order No. 72-12,597.
Thesis.

The nuclear magnetic resonance (NMR) frequency shifts of the ^{169}Tm nucleus in the NaCl-type intermetallic compounds TmP, TmAs, TmSb, and TmBi were measured at 4.2°K over a wide range of applied magnetic field strengths. Within experimental error, the shifts for TmAs and TmBi were found to be field-independent for field strengths below 3.5 kOe, but a relatively strong field dependence was measured for TmP. In the case of TmP, measurements were extended beyond 6.5 kOe, corresponding to a resonance frequency of almost 180 MHz. The shifts were observed to increase with applied magnetic field strength. The shift values for TmP and TmAs at low fields agreed well with previously reported values, but agreement was not good for TmSb. The shift value for TmBi, not previously reported, was measured to be 79.9(2). This value of the shift for TmBi was based on the ^{169}Tm gyromagnetic ratio of 0.352 kHz/Oe. The peak-to-peak line width of the ^{169}Tm resonance derivative was directly proportional to the applied field, with the proportionality essentially accounted for by the bulk demagnetizing field within a magnetic powder sample, except in the case of TmBi. The extrapolated zero-field line widths were roughly five times the calculated nuclear dipolar widths. In addition, the magnetic field dependence of the ^{31}P resonance line width in the TmP sample was found to be essentially the same as that of ^{169}Tm in the same sample; this finding supports the conclusion that the bulk sample demagnetization dominates the field dependence of the line width in these samples. A brief study of impurities in TmSb samples showed that the field dependence of the line width was greatly increased by sample impurities, but the resonance shift in these samples was essentially unaffected by impurity content. A search was made of 4.2°K for ^{141}Pr and ^{169}Tm resonances in a number of other intermetallic compounds and alloys. No resonance was detected in $TmSn_3$, $TmRh_2$, or $TmAl_2$, but a very weak resonance was observed in $TmNi_2$. None of a series of Pr−Th alloys of composition Pr_xTh_{1-x} ($x = 0.5$, 0.25, 0.1, or 0.05) yielded a detectable resonance. Similarly, no resonance was observed in a Pr−Y alloy of composition $Pr_{0.4}Y_{0.6}$. An alloy, $Tm_{0.25}Th_{0.75}$, gave no resonance, but an intense, broad, anisotropic thulium resonance was observed in the alloy, $Tm_{0.25}Sc_{0.75}$. Finally, no resonance could be identified in a Tm−Ag alloy, $Tm_{0.04}Ag_{0.96}$. (Diss. Abstr. Int., B)

32727 APPLICATIONS OF SOME MAGNETIC AND ELECTRICAL PROPERTIES IN STRUCTURAL INORGANIC CHEMISTRY. Karkhanavala, M. D. (Bhabha Atomic Research Centre, Trombay, India). pp 23–50 of Proceedings of the Chemistry Symposium, 1970. Vol. I. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.1).

Two relatively less-familiar aspects useful in structural inorganic chemistry are reviewed, namely: (1) nmr of nuclei other the proton, and (2) electric resistivity, thermoelectric power (TEP), and Hall mobility, particularly of the defect solid state (nonstoichiometry). Representative studies of the nmr of nuclei such as ^{19}F and ^{51}V are first considered, followed by the studies of electric conductivity and related properties with applications noted. (5 tables, 2 figs., 44 references) (L.M.T.)

32728 NMR IN HOLMIUM METAL AT LOW TEMPERATURES. Wagg, A. R.; McCausland, M. A. H.; Mackenzie, I. S. (Univ. of Manchester, Eng.). pp 477–9 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

Weak spin echoes from polycrystalline Ho were observed at 1.4°K and 5.9 to 6.8 GHz. A zero-time spectrum with a well-defined set of seven lines was reconstructed. The possibility of the signals arising from nuclei in domain walls or ferromagnetically ordered closure domains rather than from nuclei in the conical phase is considered, and it is concluded that the zero-field signals are due to nuclei in the conical phase. Ways of escaping from the consequences of the Elliott−Lange theorem are discussed. (D.L.C.)

32729 NUCLEAR MAGNETIC RESONANCE IN ALLOYS AND INTERMETALLIC COMPOUNDS OF HOLMIUM. Mackenzie, I. S.; McCausland, M. A. H.; Wagg, A. R.; (and others) (Univ. of Manchester, Eng.). pp 480–3 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

Studies of transferred hyperfine interactions in Ho alloys and intermetallic compounds were made, using spin echo of ^{165}Ho at 1.4 to 4.2°K. The relaxation characteristics are described, and the values of the parameters of the spin Hamiltonian are discussed. The environmental contribution to the total effective field is believed to be principally due to a direct contact interaction between the nucleus and conduction electrons polarized by the localized 4f spins. Preliminary results of measurements on various holmium alloys and dilute solutions in rare earth alloys are described briefly. (D.L.C.)

32730 NUCLEAR RESONANCE OF ^{89}Y IN PURE Y METAL AND IN Y–Ce ALLOYS. Silhouette, D. (Faculte des Sciences, Orsay, France). pp 496–7 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971). (In French).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

The NMR of ^{89}Y was observed by the echo method. The line shape was obtained by the Fourier transformation. It was studied in both Y metal and Y−Ce alloys. (auth)

32731 FORBIDDEN HYPERFINE STRUCTURE TRANSITIONS OF $^{155}Gd^{3+}$ IN A ThO_2 SINGLE CRYSTAL. Bacquet, G.; Bonnet, M.; Dugas, J.; Escribe, C. (Faculte des Sciences, Toulouse). pp 745–7 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

The ESR spectrum of a ^{155}Gd-doped ThO_2 single crystal was measured at room temperature with an X band spectrometer. Crystalline field splitting of the $^8S_{7/2}$ state of $^{155}Gd^{3+}$ occurs, and the spectrum may be fitted by a spin Hamiltonian. Three extra lines may be seen in the ($M = -\frac{1}{2} \rightarrow \frac{1}{2}$) fine-structure transition only. An attempt was made to use second-order perturbation theory, and the eigenstates are given. (D.L.C.)

32732 NUCLEAR MAGNETIC RESONANCE IN σ PHASE AND V_3Co OF V−Co SYSTEM. Nakajima, H.; Mori, N.; Mitsui, T. (Hokkaido Univ., Sapporo). pp 859–61 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

The NMR of ^{51}V and ^{59}Co was examined in the σ-phase and the β−W (V_3Co) phases of the V−Co system. The ^{51}V resonance in the σ-phase ($V_{65}Co_{35}$ and $V_{50}Co_{50}$) showed a narrow center peak and wide quadrupolar broadening in the wings, and the ^{59}Co line widths were 70 to 120 G and seen at 4.2°K but not above 77°K. For V_3Co, well-defined quadrupole splittings were seen in the ^{51}V resonance, and a sharp, long-tailed absorption was obtained in the ^{59}Co resonance. Knight shifts were also determined. (D.L.C.)

32733 NUCLEAR QUADRUPOLE RESONANCE OF ^{14}N IN SOLID NITROGEN: ISOTOPE EFFECTS AND TEMPERATURE DEPENDENCE. Scott, T. A.; Brookeman, J. R.; McEnnan, M. M. (Univ. of Florida, Gainesville). pp 1041–4 of Magnetic Resonance and Related Phenomena. /Ursu, Ioan (ed.). Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1971).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

Nuclear quadrupole resonance spectra of ^{14}N in annealed solid α-nitrogen consisting of ^{14}N−^{15}N isotopic mixtures were studied as a function of ^{15}N concentration (0.37 to 98%) and temperature (4.2 to 36°K). Most of the temperature dependence remains after correction for thermal expansion and is therefore of thermal origin. Addition of ^{15}N broadens the lines; the resonance frequency of the ^{14}N−^{15}N molecule is about 8 kHz higher than that of the ^{14}N−^{14}N molecule. (D.L.C.)

32734 $AuAl_2$–$AuGa_2$–$AuIn_2$ PROBLEM: KNIGHT SHIFTS AND RELAXATION TIMES IN THEIR PSEUDOBINARY ALLOYS. Carter, G. C. (National Bureau of Standards, Gaithersburg, Md.); Weisman, I. D.; Bennett, L. H.; Watson, R. E. Phys. Rev., B; 5: No. 9, 3621–38(1 May 1972).

The nuclear magnetic resonance (NMR) and susceptibility behavior of the intermetallic compound $AuGa_2$ differs anomalously from the isoelectric and isostructural compounds $AuIn_2$ and $AuAl_2$. In an effort to test and extend the explanation offered by Jaccarino et al. and by Switendick and Narath, spin−lattice relaxation times and Knight shifts were measured as a function of temperature and composition for the $AuAl_2$−$AuGa_2$, $AuAl_2$−$AuIn_2$, and $AuGa_2$−$AuIn_2$ pseudobinary alloy systems. At high temperature, the solute X (Al, In, Ga) resonance properties were dominated by the host. Satellite resonances were observed with temperature dependences differing from the main resonance. The results are partially explainable on the basis of an average-band model and partially on a local atom model. The role of the Au d bands is discussed. Metallurgical results on alloying were obtained using the NMR data. (auth)

32735 MAGNETIC RESONANCE STUDIES OF HYDROGEN-BONDED ARSENATES. Dalal, Nar Singh. Vancouver, B. C.; Univ. of British Columbia (1971). National Library of Canada, Ottawa.

Thesis.

EPR, ENDOR, and double ENDOR were used to obtain detailed information on hydrogen bonding and on the role of protons and heavier nuclei in the phase transitions in the x-irradiated ferroelectrics KH_2AsO_4, KD_2AsO_4, RbH_2AsO_4, mixed KH_2PO_4−KH_2AsO_4, and the antiferroelectric compound $NH_4H_2AsO_4$. The paramagnetic center AsO_4^{4-}, formed by the capture of an electron by an AsO_4^{3-} ion, was used as a microscopic probe. EPR investigations, combined with the use of electric fields, resulted in an accurate interpretation of the ^{75}As hyperfine structure in the EPR spectra of AsO_4^{4-}. The use of EPR to obtain the dielectric hysteresis loop was demonstrated for the first time. ENDOR studies of the AsO_4^{4-} center in KH_2AsO_4 at 4.2°K yielded accurate superhyperfine parameters. The results provide evidence for covalent character in both the O-H ···· and O ···· H- parts of the O-H ···· O bond in such systems. A new method was proposed for determining the signs of hyperfine couplings for $S = 1/2$ systems and is illustrated by application to the AsO_4^{4-} center in KH_2AsO_4. Analysis of the temperature dependence of the EPR spectra indicates that both the ^{75}As and the protons perform jump-type motions. At lower temperatures, however, the correlation times for the ^{75}As and the proton motions are found to be essentially the same. This provides experimental evidence for the recently postulated coupled proton–lattice motion in these systems. A method for performing electron-nuclear triple resonance experiments was demonstrated. This development may extend the range of applicability of the ENDOR technique. (Diss. Abstr. Int., B)

32736 COMPUTER ANALYSIS OF MOESSBAUER SPECTRA. Chrisman, B. L.; Tumolillo, T. A. (Univ. of Illinois, Urbana). Comput. Phys. Commun.; 2: No. 6, 322-30(Oct-Nov 1971).

Experimental Moessbauer data are fitted to a sum of Lorentzian lines. The program allows for several types of background: flat, sloping, or parabolic. The parameters for the background are fitted simultaneously with the Lorentzian parameters. (M.O.W.)

32737 MAGNETIC RESONANCE IN EUROPIUM METAL. Ehara, S.; Arrott, A. (Simon Fraser Univ., Burnaby, B. C.). pp 1200-3 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

Paramagnetic resonance data are given for Eu metal and alloys of Eu in Yb and Y. The results are compared with the g-value of Gd. The differences are attributed to the role of the d-band electrons as discussed by Coles et al. The resonances followed below the Néel temperature in Eu are associated with a low-lying excitation of the helical magnetic structure. (auth)

32738 IMPURITY-INDUCED NUCLEAR SPIN–LATTICE RELAXATION IN $LaAl_2Ce$ AND $LaAl_2Tm$. McHenry, M. R. (Univ. of California, Santa Barbara); Silbernagel, B. G.; Wernick, J. H. pp 1493-7 of Magnetism and Magnetic Materials, 1971. Pt. II. /Graham, C. D. Jr. (ed.). New York; American Inst. of Physics (1971).

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The impurity contribution to the spin–lattice relaxation of the ^{27}Al nuclei was studied in the compounds $La_{0.99}Ce_{0.01}Al_2$ and $La_{0.95}Tm_{0.05}Al_2$. The impurity component of the magnetization recovery is observed to be nonexponential, which is attributed to diffusionless relaxation of the nuclei to the magnetic impurities. An analysis of the functional dependence of the resulting rate, $1/\tau_1$, indicates that longitudinal fluctuations of the dipolar field are the principal relaxation mechanism. An analysis in the RKKY approximation indicates the strength of the impurity–conduction-electron coupling in the Ce and Tm cases, respectively, is 2.5 and 1.7 times that for $LaAl_2Gd$. (auth)

32739 NUCLEAR MAGNETIC RESONANCE IN PALLADIUM–ALUMINUM AND PALLADIUM–VANADIUM ALLOYS. Kohzuki, Shohtaro; Asayama, Kunisuke (Osaka Univ.). J. Phys. Soc. Jap.; 32: No. 5, 1237–41(May 1972).

The concentration dependence of nuclear spin–lattice relaxation time, T_1, and the Knight shift of ^{27}Al and ^{51}V in Pd–Al and Pd–V alloys were measured in the temperature range from 1.4 to 4.2°K. The measured T_1T and the Knight shift of impurities in diluted Pd–Al and Pd–V alloys are 24.8 ± 3.0 sec K, –0.002 ± 0.005% and 3.0 ± 0.2 sec K, +0.75 ± 0.02%, respectively. A consistent explanation for the electronic state in the impurity site is given using the results of T_1 and the Knight shift. Especially, the results in the dilute Al alloys are discussed with the recent Kanamori–Terakura theory which has been established for ferromagnetic Ni alloys. (auth)

32740 HYPERFINE FIELDS AS A MEASURE OF BULK PROPERTIES OR ATOMIC LOCATION. Deutch, B. I. (Univ. of Aarhus, Denmark). Radiat. Eff.; 12: No. 3-4, 193-202(Feb 1972).

Recent progress in the field of hyperfine interactions is surveyed. The perturbed angular correlation technique is described and various applications are discussed. Atom location measurements by hyperfine interactions are compared to similar channeling measurements. (auth)

Theory

Refer also to abstract 31645.

PHYSICS (THEORETICAL)

Refer also to abstracts 31975, 31997, 32089, 32298, and 32448.

32741 (CNRS-CPT-71-P-412) IMPROPER STATES OF CANONICAL COMMUTATION RELATIONS FOR A FINITE NUMBER OF DEGREES OF FREEDOM. Sirugue, M. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). Oct 1971. 18p. (In French). Dep. NTIS (U. S. Sales Only).

Using the Weyl description of the canonical commutation relations (C.C.R.) for systems with a finite number of degrees of freedom, a precise meaning is given to the so-called improper states such as plane waves and localized states. The main properties of the representations of the C.C.R. associated with these states are described. (France)

32742 (IA-1226) GENERALIZED SCHUR TEST. Ronen, Yigal (Israel Atomic Energy Commission, Tel Aviv). Sep 1970. 6p. Dep. NTIS (U. S. Sales Only).

Criteria for the boundedness of integral operators in Hilbert space and for obtaining a low estimate for the norm of the operator are presented. (auth)

32743 (JUL-816-MA) GENERALIZED SOLUTION OF EIGENVALUE PROBLEMS BELONGING TO DEVELOPMENT QUESTIONS AND USE OF TRANSPORT THEORY EQUATIONS. Neunzert, Helmut (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Angewandte Mathematik). Dec 1971. 108p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen (West Germany).

The problem of the degree to which the distribution function of a gas within a 6-dimensional position and velocity space is determined by its spacial density was studied. Vectorial generalized functions, the eigenvalue problem, application of eigenvalues upon matrices and common differential equations of the transport theory are treated. Included are both the 1-dimensional case and the multidimensional case. (H.B.G.)

32744 (KFKI-72-3) COMPLETE SET OF FUNCTIONS IN THE QUANTUM MECHANICAL THREE-BODY PROBLEM. Nyiri, J. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1970]. 34p. Dep. NTIS (U. S. Sales Only).

A complete set of basis functions for the quantum mechanical three-body problem is chosen in the form of hyperspherical functions. These functions are characterized by quantum numbers corresponding to the chain $0(6) \supset SU(3) \supset 0(3)$. Equations are derived to obtain the basis functions in an explicit form. (auth)

32745 (NP-19290) RIGOROUS THEORY OF THE BOLTZMAN EQUATION IN THE LORENTZ GAS. Note No. 358. Gallavotti, G. (Rome Univ. (Italy). Istituto di Fisica). 10 Feb 1972. 21p. Dep. NTIS (U. S. Sales Only).

A proof is given of the Boltzmann limit conjecture in the case of a two-dimensional Lorentz gas with hard-core interactions and free gas distribution. (J.F.P.)

32746 STIGMA OF A DIRAC PARTICLE IN AN EVEN ENVIRONMENT. Good, R. H. Jr. (Ames Lab., Iowa); Biedenharn, L. C.; Han, M. Y.; van Dam, H. Phys. Rev., D; 5: No. 6, 1538-9 (15 Mar 1972).

Solutions of the Dirac equation for a particle in reflection-invariant electromagnetic fields have a definite stigma. It coincides with the relativistic parity quantum number. Two different interpretations of this result are given. (auth)

32747 SHELL-STRUCTURE OF AN L-MATRIX. Ramakrishnan, Alladi (Inst. of Mathematical Sciences, Madras). J. Math. Anal. Appl.; 38: No. 1, 106-8(Apr 1972).

The problem of starting with $(2n + 1)$ anticommuting matrices identifying the commuting matrices and discerning the shell structure is considered. The case of the Dirac equation is mentioned. (J.F.P.)

32748 ORDER-OF-SCATTERING THEORY FOR TRANSPORT PROCESSES. Mingle, John O. (Kansas State Univ., Manhattan). J. Math. Anal. Appl.; 38: No. 1, 53-60(Apr 1972).

The approach used is to follow the buildup of the particle reflections and transmissions by considering the effect of each successive scattering interaction. It is noted that if a small probability for scatter exists then only a few orders of scattering need to be considered. Invariant imbedding in slab geometry is used whereby the primary function of importance becomes the reflection function. The transmission function is also considered. (J.F.P.)

REACTOR TECHNOLOGY

Power Reactor Development

32749 (CONF-720316-1) GAS-COOLED POWER REACTORS AND THEIR THERMAL FEATURES. Kasten, P. R.; Trauger, D. B. (Oak Ridge National Lab., Tenn.). [1971]. Contract W-7405-eng-26. 26p. Dep. NTIS.

From eighth annual seminar on thermal sciences; Nashville, TN. (23 Mar 1972).

The general features of the high-temperature gas-cooled reactor and the gas-cooled fast breeder reactor are reviewed. The potential capabilities of gas-cooled reactors are discussed, with emphasis on their thermal design and performance. (H.D.R.)

32750 (GULF-GA-A-10906) GAS-COOLED FAST BREEDER REACTOR. Quarterly Progress Report, August 1–October 31, 1971. (Gulf General Atomic Co., San Diego, Calif.). 30 Nov 1971. Contract AT(04-3)-167. 55p. Dep. NTIS.

The tasks of the Gas-Cooled Fast Breeder Reactor (GCFR) program are program planning, core development, fuels and materials development, and nuclear analysis and reactor physics. The status of the development program planning document for the 300-MW(e) GCFR demonstration plant is given. Core development work included analytical studies of fuel-rod spacers, grid-plate response to thermal transients, and the forces acting on the fuel-element clamping mechanisms. The test results and analyses of the capsule GB-9 irradiation in the ORR and the status of the fast-flux irradiation program are reported. Also presented are the analytical results of irradiated SiC temperature monitors. Reactor physics work included calculations of critical mass and reaction rate ratios in the ZPPR-2 critical assembly and analyses of small-sample worths in ZPR-6, Assembly 7. (auth)

32751 (GULF-GA-A-10930) HTGR BASE PROGRAM QUARTERLY PROGRESS REPORT FOR THE PERIOD ENDING NOVEMBER 30, 1971. (Gulf General Atomic Co., San Diego, Calif.). 31 Dec 1971. Contract AT(04-3)-167. 31p. Dep. NTIS.

The High-temperature Gas-cooled Reactor (HTGR) development work reported includes studies of basic fission-product distribution mechanisms, recycle fuel studies (including designing and testing of recycle test elements, development of a national recycle plan and of a recycle fuel plant, and exploration of head-end reprocessing methods), and physics and fuel management studies (including design and fabrication of fuel test elements, and physics tests performed in the HTLTR). Materials studies include irradiation and analysis of fuel particles in capsules to evaluate startup and recycle fuel systems, and basic studies of control materials and of carbon and graphite. Experimental procedures and results are discussed and, where appropriate, the data are presented. (auth)

32752 (GULF-GA-A-12003) GAS-COOLED FAST BREEDER REACTOR. Quarterly Progress Report for the Period November 1, 1971–January 31, 1972. (Gulf General Atomic Co., San Diego, Calif.). 29 Feb 1972. Contract AT(04-3)-167. 60p. Dep. NTIS.

The tasks of the Gas-Cooled Fast Breeder Reactor (GCFR) program are program planning, core development, fuels and materials development, and nuclear analysis and reactor physics. The status of the development program planning document for the 300–MW(e) GCFR demonstration plant is given. Core development work included studies of fuel-rod surface-roughening modifications to reduce fuel-rod bowing, analytical studies of neutron irradiation effects on the grid plate, and analysis of the pressure equalization system. The status of the thermal-flux and fast-flux irradiation programs is presented. Postirradiation examination of the fuel-rod irradiated in capsule GB–9 in ORR is under way and gamma scans are being made. Reactor physics work continued on the analyses of small-sample worths. (auth)

32753 (JUL-796-RX) CENTRAL INSTITUTE FOR REACTOR EXPERIMENTS OF THE JUELICH NUCLEAR RESEARCH CENTER. RESULTS AND POSSIBILITIES. Pollermann, Max (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). Oct 1971. 79p. (In German). Dep. NTIS (U. S. Sales Only).

Presented are the organization, installations, and achievements of the central institute for reactor experiments at Juelich. The institute offers technical support in the following areas: reactor techniques, radiation measurement, radiation facilities in reactors, mathematical procedures for circuits, test facilities for high and low temperatures, equipment for calorimetry, heat conduction, moisture, technical gas analysis, and refrigeration facilities. The division of electrotechniques constructs equipment for monitor-, control-, and safety systems as well as for data evaluation. Production technology offers new procedures for welding and soldering. The test group supplies installations for the evaluation of materials, alloys, components, and low temperature experiments. Numerous practical examples are given. (H.B.G.)

32754 (TID-3333(Pt.1)) LIQUID METAL FAST BREEDER REACTORS, 1948–1961. (Technical Information Center (AEC), Oak Ridge, Tenn.). 121p. Dep. NTIS.

An annotated bibliography is presented for literature contained in Nuclear Science Abstracts from 1948 through 1961, Volumes 1 through 15, on the topic of sodium and NaK cooled fast breeder reactors. Abstracts are divided by year/NSA volume number and are arranged by original abstract number. The subject indexes refer to these abstract numbers. All the literature cited is publicly available. Information is indexed to names of specific reactors and general headings such as critical assemblies, fast reactors, and liquid metal cooled reactors. (D.C.C.)

32755 (TID-3333(Pt.2)) LIQUID METAL FAST BREEDER REACTORS, 1962–1971. (Technical Information Center (AEC), Oak Ridge, Tenn.). 712p. Dep. NTIS.

An annotated bibliography is presented for literature contained in Nuclear Science Abstracts from 1962 through 1971, Volumes 16 through 25, on the topic of sodium and NaK cooled fast breeder reactors. Abstracts are divided by year/NSA volume number and are arranged by original abstract number. The subject indexes refer to these abstract numbers. All the literature cited is publicly available. Information is indexed to names of specific reactors and general headings such as critical assemblies, fast reactors, and liquid metal cooled reactors. (D.C.C.)

32756 (TRG-Report-2152) RECOMMENDED IRON ATOMIC DISPLACEMENT CROSS SECTIONS AND DISPLACEMENT RATES FOR USE IN FAST REACTORS. Nelson, R. S.; Etherington, E. W.; Smith, M. F. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1972. 33p. Dep. NTIS (U. S. Sales Only). UK 1.00 pound.

A new model of atomic displacement production in iron, known as the Half-Nelson model, is described. This model was used for estimating absolute iron displacement rates in fast reactors and for accelerator experiments. Displacement cross sections in 35 groups and also displacement rates in the fast reactors DFR and PFR are presented. (17 references) (auth)

32757 USE OF COMPUTERS IN THE DESIGN AND COMMISSIONING OF POWER STATION PLANT. Blake, R. G. (Central Electricity Generating Board, London). Elec. Rev.; 190: No. 13, 433-6(31 Mar 1972).

The two main types of mathematical models used in the design and commissioning of power station plant are considered. Steady state models for the design of plant items such as nuclear reactors are algebraic and written in modular form. For external disturbances and internal fault conditions dynamic models, expressed as differential equations, are used. The factors involved for formulating models for a digital computer, the advantages and disadvantages of analogue and hybrid computers, and economic considerations, are discussed. A typical hybrid computer model of a nuclear station is illustrated. (UK)

Physics and Core Engineering

32758 (COO-3060-1) NEUTRONICS OF AN LMFBR BLANKET MOCK-UP. Leung, T. C.; Driscoll, M. J.; Kaplan, I.; Lanning, D. D. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Jan 1972. Contract AT(11-1)-3060. 186p. (MITNE-127). Dep. NTIS.

Experimental measurements using foil activation techniques were performed on an LMFBR blanket mock-up, made up of subassemblies of 0.25-inch-diameter uranium metal fuel rods, clad in low-carbon steel, and surrounded by anhydrous sodium chromate (Na_2CrO_4) powder. The work was carried out in the MIT Blanket Test Facility which employs a converter assembly to transform the highly thermalized neutrons from the reactor's thermal column into a spectrum typical of LMFBR core leakage neutrons. Vertical and horizontal traverses were made in the blanket mock-up to confirm that an energy-independent buckling characterized the transverse leakage. Axial reaction rate traverses of numerous materials including $^{238}U(n,\gamma)$, $^{238}U(n,f)$, $^{235}U(n,f)$ and $^{239}Pu(n,f)$ were made throughout the blanket and reflector regions. Experimental results were compared with 26-group, S_8 calculations. In general, the agreement was good except in the iron reflector. The degree to which the ^{238}U capture cross section was self-shielded was found to be the factor having the greatest affect on the calculations. Multiple-foil packets containing resonance and threshold absorbers were irradiated at various locations within the blanket and neutron spectra unfolded from measured activities using a method based on reactor slowing-down theory. The unfolded blanket spectra were found to be harder than calculated using shielded ^{238}U cross sections, but softer than calculated using unshielded ^{238}U cross sections. (auth)

32759 (COO–3060-2) USE OF GAMMA SPECTROSCOPY FOR NEUTRONIC ANALYSIS OF LMFBR BLANKETS. Kang, Chang-Sun; Rasmussen, Norman C.; Driscoll, Michael J. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Nov 1971. Contract AT(11-1)-3060. 315p. (MITNE–130). Dep. NTIS.

An investigation to extend and apply Ge(Li) gamma-ray spectroscopy to the study of fast reactor blankets is described. The focal point for the research was the Blanket Test Facility at the MITR and Blanket No. 2, a realistic mockup of the blanket-reflector region of a large liquid metal cooled fast breeder reactor. It was found that Ge(Li) detectors can be simultaneously used as both high energy neutron spectrometers and continuous gamma-ray spectrometers. The broadened internal conversion spectral line at 691.4 keV was analyzed for the former purpose, and the Compton recoil continuum was analyzed and unfolded for the latter. This development makes the Ge(Li) spectrometer an extremely valuable shield analysis tool. The moisture content of the sodium chromate used in the blanket mockup was confirmed to be less than 0.1 w/o by prompt activation analysis. Prompt capture and inelastic gamma, and decay gamma spectra emitted by the blanket were also analyzed to perform a neutron balance with mixed results. The inability to resolve ^{238}U prompt capture gammas made it necessary to use the low energy ^{239}Np decay gammas, with the attendant uncertainties due to large self-shielding corrections. Lack of data on the variation of prompt gamma yield with neutron energy for all blanket constituents also contributed to the uncertainties which together made it impossible to develop this method to the point where reliable practical application can be recommended. (auth)

32760 (EURFNR–933) FAST BREEDER PROJECT. First Quarterly Report, 1971. (Kernforschungszentrum, Karlsruhe (West Germany)). Translation of report KFK–1271/1. 221p. Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Information on the development of fast breeder reactors in the Federal Republic of Germany is presented under the following headings: fuel rod development, materials examination and development, corrosion tests and coolant analyses, fuel cycle, reactor theory, safety of fast reactors, development of the instrumentation and signal processing for nuclear monitoring, effects of reactor operations on the environment, sodium tests, thermodynamic and hydrodynamic tests in gas and steam, design studies for gas and steam cooled breeder reactors, and design studies for sodium cooled breeder reactors. (D.C.C.)

32761 (ORNL-tr-2584) DEPENDENCE OF THE DESIGN CHARACTERISTICS OF FAST POWER REACTORS ON THE VARIATIONS OF THE USED DESIGN CONSTANTS AND NECESSARY ACCURACY OF THESE CONSTANTS. Zaritskii, S. M.; Troyanov, M. F. Translated for Oak Ridge National Lab., from Proceedings of Soviet, Dutch, and Belgian Tripartite Conference, Melekess, USSR, February 23–28, 1970. 24p. (CONF-700217–1). Dep. NTIS.

Using the methods of perturbation theory, data were obtained characterizing the sensitivity of the calculated critical parameters and breeding ratios of fast power reactors to the variation of constants employed in the design calculation. Reactors with metal, plutonium carbide and oxide fuel and core volumes of 2.5 and 5 m^3 were examined. A method is discussed for estimating the error of these constants which may be permissible from the point of view of the required accuracy of reactor design calculations. Actual estimates were made of the required accuracy of σ_c, σ_f and ν_f of ^{238}U and ^{239}Pu so that an acceptable accuracy of these calculated characteristics be obtained. (auth)

32762 (WCAP–7810) EVALUATION OF NUCLEAR HOT CHANNEL FACTOR UNCERTAINTIES. (Westinghouse Electric Corp., Pittsburgh, Pa.). Dec 1971. 61p.

Detailed measurements were carried out at the Connecticut Yankee and Zorita nuclear power stations to determine the uncertainties associated with flux mapping measurements using the recently developed miniature moveable detector systems. The results of this study were combined with critical experiments performed at the Westinghouse Reactor Evaluation Center to assess the uncertainty associated with the measurement of the various factors used to determine the peak nuclear heat flux factor. It was determined that the probability of not exceeding an uncertainty of 4.58% in the peak nuclear heat flux factor is 95% at a 95% confidence level. (8 references) (auth)

32763 NUCLEAR DATA AND FAST REACTORS. Crowe, D. S.; Sinclair, V. M. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). pp 101–8 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

Many aspects of the design, operation and safety of fast reactor systems are influenced by the basic nuclear data. In an operating fast reactor nuclear data are used in calculations employed to ensure that the reactor is operated in a safe and efficient manner. The exact manner of operation will depend on the role of the reactor, e.g., whether the reactor is being used to prove a basic design, whether it is being used as a materials test reactor, or whether it is being used for power production. Experience gained in the operation of DFR (Dounreay Fast Reactor) is discussed. In the DFR nuclear data are required to decide such operational requirements as fuel charging or discharging programs, irradiation conditions for experimental material irradiations, temperature assessments, prediction of kinetic behavior, and aspects of the neutron spectra. The effects of radiation on the metallurgical and chemical properties of the materials used in the construction and operation of a fast reactor have to be considered. Various nuclear cross-sections are used in the evaluation of these effects, and neutron as well as γ flux and dose levels are among the data required. In considering the behavior of the fuel in the reactor the yields of the various fission products are of importance. These yields also play an important part in the design and operation of irradiated fuel reprocessing plants, as well as in the disposal and storage of associated effluents. (13 references) (auth)

Control and Instrumentation

32764 (ANL–7905) INSTRUMENTATION AND CONTROL ACTIVITIES AT ARGONNE. Annual Report for Period Ending June 30, 1971. Scheibelhut, C. H. (comp.) (Argonne National Lab., Ill.). Dec 1971. Contract W-31-109-eng-38. 69p. Dep. NTIS.

The status of instrumentation and control activities in the LMFBR program during fiscal year 1971 is described. Activities supporting near-term objective (e.g., operation of the FFTF) to long-term objective (e.g., commercial LMFBR plants) are described. Reactor monitoring techniques, plant control, FEDAL systems, nondestructive testing, and instrument test facilities are described, as well as the systems for measuring reactor-system parameters. (auth)

32765 (BNL–16726) CONTROL CLUSTER WORTHS AND OTHER ASPECTS OF PWR SAFETY ANALYSIS. Diamond, David J. (Brookhaven National Lab., Upton, N. Y.). Sep 1970. 39p. (RP–1016). Dep. NTIS.

Several studies of reactor physics problems pertinent to the safety of a PWR are presented. The emphasis is on the obtaining of control cluster worths which are of interest in the analysis of abnormal operating conditions. This included ejected rod, stuck rod and dropped rod studies as well as worth changes for a cluster left in the core. The effect of various quantities on control cluster worth was also considered. These studies take into account soluble boron concentration, burnup, and the effect of other clusters. This latter topic includes the effect of part length clusters and adjacent clusters. A study of the nuclear enthalpy rise hot channel factor is also given. (auth)

32766 (CONF-720420–2) PERFORMANCE MODELING OF NEUTRON ABSORBERS. Homan, F. J. (Oak Ridge National Lab., Tenn.). [1972]. 33p. Dep. NTIS.

From Conference on reactor materials performance; Richland, WA. (24 Apr 1972).

The components of a computer code to predict the performance of fast reactor control rods are presented and discussed. Predictions of integrated performance of a typical FTR-type control rod in row 2 of EBR-II are included to demonstrate the predicted influence of the ^{10}B enrichment and solid reaction product swelling. Models for helium gas bubble swelling and release are presented, which suggest minimum swelling from this source at about 1000°C. It is noted that control rods are predicted to fail very shortly after the fabricated gap between the absorber pellets and the cladding has closed, due to high contact pressure which develops with continued pellet swelling. 25 references. (auth)

32767 (IAEA-TA-536) REACTOR INSTRUMENTATION. Report to the Government of Argentina. Takamatsu, S. (International Atomic Energy Agency, Vienna (Austria)). 24 Apr 1970. 4p. INIS.

Information is presented on the technical assistance given by the International Atomic Energy Agency (IAEA) to Argentina under its regular program 1968 to train and advise a group of staff in automatic control and measurement systems based on digital techniques for reactor operation. (auth)

32768 (KURRI-TR-89) THIRD NEUTRON MEASUREMENT SYMPOSIUM. Kanda, Keiji; Kimura, Itsuro (eds.) (Kyoto Univ. (Japan). Research Reactor Inst.). 15 Mar 1971. 70p. (In Japanese).

Neutron measurement equipment and techniques for reactor studies are surveyed. Topics discussed include neutron detectors, neutron spectroscopy, in-core measurements in power reactors, nuclear instrumentation in the Japanese fast breeder reactor and advanced thermal reactor, and neutron sources. (H.D.R.)

32769 (WCAP-7817(Suppl.1)) SEISMIC TESTING OF ELECTRICAL AND CONTROL EQUIPMENT (WCID PROCESS CONTROL EQUIPMENT). Vogeding, E. L. (Westinghouse Electric Corp., Pittsburgh, Pa.). Dec 1971. 9p.

Process instrumentation in the Westinghouse system consists of a three-cabinet unit containing signal conditioning equipment for monitoring pressurizer level and pressure, containment pressure, reactor coolant flow and temperature, and steam generator level and pressure. The results of seismic simulation testing of the process instrumentation are presented. (H.D.R.)

32770 FUEL ACTIVITY RELEASE MONITORING (BURST FUEL DETECTION) IN THE UK GAS COOLED REACTORS. Leake, J. W. (Atomic Energy Research Establishment, Harwell, Eng.). pp 247-50 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

The burst cartridge detection gear (BCDG) used in the U.K. Mk. I (Magnox) and Mk. II (AGR) gas-cooled reactor programs consists mainly of wire precipitator systems, supplemented by delayed-neutron detectors on some reactors; these are briefly described. The Mk. III design of high-temperature gas-cooled reactors (H.T.R.'s) will use helium coolant and coated fuel particles, and their activity release monitoring requirements differ considerably from those on the Mk. I and II reactors. The systems being considered for the Mk. III are described; and their theoretical performances compared. The need for more nuclear data is discussed. (8 references) (auth)

Containment Systems, Waste Processing, and Radiation Protection

32771 PHYSICS PROBLEMS OF REACTOR SHIELDING. Joint ENEA-AIEA Specialist Meeting, Paris, France, December 8, 1970. Paris; Prganization for Economic Co-Operation and Development ([1971]). 175p. $5.00. (CONF-701228).

Eleven review papers were presented from Euratom, the United States, the Federal Republic of Germany, Italy, France, the United Kingdom, Japan, Switzerland, India, Norway and the Netherlands. The progress made in developing shielding calculation methods since the international meeting on reactor shielding in 1967 is exposed. The 9 individual papers included in the report from Germany were processed separately and 5 of them were abstracted. Abstracts are presented for 14 papers. One paper was previously abstracted for NSA and may be located under CONF-701228 in the Report Number Index. (France)

For abstracts of individual papers see: 32772–32785.

32772 SHIELDING FOR ADVANCED REACTORS IN THE UNITED STATES. Maienschein, F. C.; Clifford, C. E.; Mynatt, F. R.; Abbott, L. S. (Oak Ridge National Lab., Tenn.). pp 15-37 of Physics Problems of Reactor Shielding. Paris; Organization for Economic Co-Operation and Development (1971).

From Specialist meeting on the physics problems of reactor shielding; Paris, France (8 Dec 1970). See CONF-701228.

The efforts in developing methods for designing advanced reactor shields in the U. S. are surveyed. The description is largely qualitative, a broad coverage of calculational methods (Monte Carlo method, transport method) neutron and γ-ray cross section requirements and availability, and facilities for experimental tests being given. Work on shielding for the specific reactor types is very much still in progress and few coherent descriptions have been published. Studies at the Oak Ridge National Laboratory are emphasized. These general methods are being applied in the LMFBR program and in the space program. 120 references. (France)

32773 TODAY'S APPROACHES TO REACTOR SHIELDING PROBLEMS. Nicks, R.; Penkuhn, H. (EURATOM, Ispra, Italy). pp 39-53 of Physics Problems of Reactor Shielding. Paris; Organization for Economic Co-Operation and Development (1971).

From Specialist meeting on the physics problems of reactor shielding; Paris, France (8 Dec 1970). See CONF-701228.

The neutron aspects of the shielding problem are discussed. Shielding transport codes were developed from reactor theory (S_n, DP_n), astrophysics (invariant embedding) or by establishing new approaches (NIOBE, CINNA). The principal advantages and drawbacks of the different methods are briefly reviewed. The problems in applied shielding physics are outlined: radiation penetration in bulk shields; propagation in complicated geometries; streaming through ducts and voids. Experimental facilities and equipment for mock-up experiments (clean experiments) and general attenuation measurements are briefly described. 27 references. (France)

32774 TODAY'S ACTIVITIES ON REACTOR SHIELDING STUDIES IN JAPAN. Miyasaka, Shun-ichi (Japan Atomic Energy Research Inst., Tokyo); Higashihara, Yoshiharu. pp 55-71 of Physics Problems of Reactor Shielding. Paris; Organization for Economic Co-Operation and Development (1971).

From Specialist meeting on the physics problems of reactor shielding; Paris, France (8 Dec 1970). See CONF-701228.

The development of calculation methods is briefly reviewed (MAC-RAD, SLDN, PALLAS and SCG-NIOBE-J1, a Japanese version of NIOBE). Experimental results obtained in verifying the applicability of removal-diffusion codes to fast breeder reactor systems are given, a series of neutron attenuation experiments being under way for nonhydrogeneous materials (iron, graphite, reduced-density Al and Na) and various concretes (ordinary concrete and serpentine concretes with and without rare-earth elements) at the JRR-4 swimming pool type-reactor. These experiments are of two types: those performed using the dry-box facility installed in the pool with threshold and resonance activation detectors, and those performed in the large experimental beam port with the fission converter plates using neutron spectrometers with ^{6}Li sandwich type semiconductor detector and ^{3}He-filled and proton-recoil proportional counters. Special items such as γ-ray buildup factors, the optimization technique and the FBR program (an approach to establish a design technique) are also presented. 29 references. (France)

32775 SHIELDING ACTIVITIES IN THE FEDERAL REPUBLIC OF GERMANY. PART 1. COMPARISON OF SHIELDING CODES MAINLY USED IN THE FEDERAL REPUBLIC OF GERMANY. Hehn, G. pp 74 of Physics Problems of Reactor Shielding. Paris; Organization for Economic Co-Operation and Development (1971).

From Specialist meeting on the physics problems of reactor shielding; Paris, France (8 Dec 1970). See CONF-701228.

Comparative calculations were made using 9 programs (PIK, DTFIV, ANISN, UNCSAM, UNION, NEAB, SABINE, RESTRAB and NRN) in order to determine neutron transport in water and sodium in view of establishing the tendency and order of magnitude of systematic errors in the shielding programs used principally in Germany. The comparisons cover dose rates and group fluxes as a function of the distance from the source. (France)

32776 SHIELDING ACTIVITIES IN THE FEDERAL REPUBLIC OF GERMANY. PART 5. INVESTIGATIONS ON THE OPTIMIZATION OF REACTOR SHIELDS. Schnier, C. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). pp 76-83 of Physics Problems of Reactor Shielding. Paris; Organization for Economic Co-Operation and Development (1971).

From Specialist meeting on the physics problems of reactor shielding; Paris, France (8 Dec 1970). See CONF-701228.

The Enginol optimization method was used to minimize the weight of a cylindrical multi-layer shield with the constraint that the dose rate after n layers has a prescribed value. The results for the optimization of the biological shield of a ship reactor are given (thickness of the selected materials). (France)

32777 SHIELDING ACTIVITIES IN THE FEDERAL REPUBLIC OF GERMANY. PART 6. METHODS OF SHIELDING CALCULATIONS AND DESIGN FOR SIEMENS-PRESSURIZED

WATER REACTORS. Weber, H. (Siemens AG, Erlangen, Ger.). pp 84-5 of Physics Problems of Reactor Shielding. Paris; Organization for Economic Co-Operation and Development (1971).

From Specialist meeting on the physics problems of reactor shielding; Paris, France (8 Dec 1970). See CONF-701228.

The calculations of neutron penetration are performed according to the removal-diffusion method and the calculations of γ-ray penetration are performed using the buildup factor-concept. The buildup factor is applied in the Taylor form. (France)

32778 SHIELDING ACTIVITIES IN THE FEDERAL REPUBLIC OF GERMANY. PART 7. REPORT ON THE WORK IN THE ARBEITSGRUPPE FUER BAUTECHNISCHEN STRAHLENSCHUTZ DER TECHNISCHEN UNIVERSITAET, HANNOVER. Schultz, H. (Technische Univ., Hanover). pp 85-7 of Physics Problems of Reactor Shielding. Paris; Organization for Economic Co-Operation and Development (1971).

From Specialist meeting on the physics problems of reactor shielding; Paris, France (8 Dec 1970). See CONF-701228.

The Arbeitsgruppe is especially interested in the development, testing and adjusting of simple approximative formulas and data libraries for the execution of shielding calculations with an accuracy that is sufficient for practical applications. 17 references. (France)

32779 SHIELDING ACTIVITIES IN THE FEDERAL REPUBLIC OF GERMANY. PART 9. SHIELDING PROBLEMS AT THE KERNFORSCHUNGSANLAGE, JUELICH. Rohloff, F. (Kernforschungsanlage, Juelich, Ger.). pp 88-90 of Physics Problems of Reactor Shielding. Paris; Organization for Economic Co-Operation and Development (1971).

From Specialist meeting on the physics problems of reactor shielding; Paris, France (8 Dec 1970). See CONF-701228.

There are two projects in hand that require an extensive shielding calculation: the helium duct of the AVR-reactor; the high-temperature reactor (HTR) planned at Juelich. Sketches of both reactors are presented. (France)

32780 SHIELDING STUDIES AT CNEN. Farinelli, U.; Rado, V. (CNEN, Casaccia, Italy). pp 107 of Physics Problems of Reactor Shielding. Paris; Organization for Economic Co-Operation and Development (1971).

From Specialist meeting on the physics problems of reactor shielding; Paris, France (8 Dec 1970). See CONF-701228.

Most of the activity to be set up at CNEN in the domain of shielding will concern fast reactors. The initial program of experiments on the Tapiro reactor will deal with the capability of removal-diffusion methods for nonhydrogeneous media. The problem is to be studied by spectrum propagation experiments. (France)

32781 SCIENCE OF REACTOR SHIELDING. AN END TO EMPIRICISM IN THE 1970's. A REVIEW OF CONTEMPORARY UNITED KINGDOM SHIELDING TECHNIQUES WITH AN INDICATION OF FUTURE TRENDS. Butler, J. (Atomic Energy Establishment, Winfrith, Eng.). pp 109-141 of Physics Problems of Reactor Shielding. Paris; Organization for Economic Co-Operation and Development (1971).

From Specialist meeting on the physics problems of reactor shielding; Paris, France (8 Dec 1970). See CONF-701228.

The development of the methods employed in the new systematic approach has been strongly influenced by the nature of the shield configurations encountered in contemporary U. K. reactor designs. The examples given are primarily concerned with the design of internal shields. The approach which is being developed is applicable to the whole range of power stations and marine propulsion shielding problems. The COMPRASH removal-diffusion method is admitted as a gross approximation; kernel-albedo models are used for an approximate estimate for neutron streaming through the walls of the ducts. The association of removal-diffusion and albedo methods with Monte Carlo has had a profound influence on U. K. shielding techniques and has resulted in the development of the family of complementary codes in the two-option scheme which forms the basis of the new recommended design procedures. The codes in this scheme are all restricted to one- or two-dimensional geometries with the exception of the Monte Carlo-albedo code RANSORD which has a generalized three-dimensional capability for ducts. 51 references. (France)

32782 REACTOR SHIELDING IN SWITZERLAND. Herrnberger, V.; Ligou, J. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). pp 143-55 of Physics Problems of Reactor Shielding. Paris; Organization for Economic Co-Operation and Development (1971).

From Specialist meeting on the physics problems of reactor shielding; Paris, France (8 Dec 1970). See CONF-701228.

The main problems tackled in Switzerland during recent years in the domain of shielding are reviewed. Computer codes of foreign origin have been tested and evaluated, and adequate radial and axial shields have been verified or defined for different types of reactors. Within the framework of the Swiss program on fast gas cooled reactors the SHADOK code, which is based on the integral transport theory, has been developed for a one-dimensional cylindrical geometry. Further developments of calculation methods (in one and two dimensions), which are more economic on computer time and core memory than S_N or similar approaches are envisaged. 30 references. (France)

32783 WORK ON RADIATION TRANSPORT IN INDIA. Gopinath, D. V. (Bhabha Atomic Research Centre, Bombay). pp 157-65 of Physics Problems of Reactor Shielding. Paris; Organization for Economic Co-Operation and Development (1971).

From Specialist meeting on the physics problems of reactor shielding; Paris, France (8 Dec 1970). See CONF-701228.

A transport code ASFIT has been developed for energy dependent radiation transport in one-dimensional systems with an arbitrary degree of anisotropy. The code is based on the collision probability method and is an extension of the SCIT code which is intended for transport calculations with low degree of anisotropy. The ASFIT formulation is briefly presented; its advantages and limitations and some typical calculations in neutron and γ ray penetration problems are emphasized. (France)

32784 APPLIED REACTOR SHIELDING. AN APPROACH TO THE SHIELDING OF POWER REACTORS. Tveten, U. (Instituut for Atomenergi, Kjeller, Norway). pp 167-70 of Physics Problems of Reactor Shielding. Paris; Organization for Economic Co-Operation and Development (1971).

From Specialist meeting on the physics problems of reactor shielding; Paris, France (8 Dec 1970). See CONF-701228.

The computational system adopted by IFA (Institutt for Atomenergi) is outlined. The choice was made from a practical point of view and is based upon practical experience gained during several years of project studies. A maximum computerization is sought, which will allow a continuous development and updating of the calculation system. The first power reactors planned in Norway are light water thermal reactors with concrete bulk shields; a removal-diffusion program MACS is envisaged for the reactor shielding calculation. The MAGNA program developed at IFA is especially designed for calculations in pipe arrangements. Another component shielding program of a more general type is being developed at IFA. Special shielding problems will be processed using the Monte Carlo codes 05R and OGRE operated at IFA. 8 references. (France)

32785 SHIELDING WORK AT REACTOR CENTRUM NEDERLAND, THE NETHERLANDS. Verschuur, K. A. (Reactor Centrum Nederland, Petten). pp 171-2 of Physics Problems of Reactor Shielding. Paris; Organization for Economic Co-Operation and Development (1971).

From Specialist meeting on the physics problems of reactor shielding; Paris, France (8 Dec 1970). See CONF-701228.

In addition to the shielding calculations made with the MACRAD code by the design group of the NERO ship propulsion reactor project, a small shielding group at the Petten research center has been working during recent years on the fundamentals of shielding. This work is briefly reviewed. (France)

Coolant System

32786 APPLICATIONS OF NUCLEAR DATA IN WATER COOLED REACTORS. Walton, G. N. (Imperial Coll. of Science and Tech., London). pp 251-7 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

Water may be used in the primary coolant of nuclear reactors either as a heat transfer medium, or as a working fluid. In both cases the circuits become radioactive and measurement of the sources of radioactivity provides guides to reactor and coolant performance. Formation of corrosion films has great importance in that it can protect the fuel and constructional materials from further corrosion, but it can lead also to reactor failure by interfering with fluid flow and heat transfer. The relationship between circuit activation and the nature of the corrosion films is discussed for the various types of water cooled reactors. (5 references) (auth)

32787 CIRCUIT CONTAMINATION IN GAS COOLED REACTORS. Freck, D. V. (Central Electricity Generating Board, Berkeley, Eng.). pp 259-63 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

The principal effect of circuit contamination in a gas-cooled reactor is to produce a gamma-ray exposure inside the circuit, limiting access to those parts of the circuit outside the core when the reactor is shut-down for maintenance and inspection. Nuclides with half-lives very much shorter than the maintenance period may be neglected. The remaining nuclides may be classified into those with half-lives such that they achieve an equilibrium level in operation, and those with very long half-lives which give a constantly rising level of gamma exposure on successive inspections. This last group poses the most serious difficulty to reactor access. Factors other than half-life, which determine the importance of fission products as circuit contaminants, are the inventory in the fuel, the ease of escape from the fuel, and the specific gamma ray constant. It is shown that, in general, most uncertainty exists about the ease of escape from the fuel, which is determined by the chemical nature of the nuclide. In particular cases, where the barriers to fission product escape are chemically selective, nuclides with small inventories may be important, and it is in these cases that the uncertainty of the basic nuclear data is probably of the greatest consequence. It is shown that in two cases, cesium and silver, cross-sections for the activation of stable nuclides produced by fission are of importance. (5 references) (auth)

32788 EFFECTS OF TRANSVERSE FLOW THROUGH GRAPHITE ON FISSION PRODUCT MOVEMENT IN HTGR-TYPE SYSTEMS. Oezisik, M. N. (North Carolina State Univ., Raleigh); Silverman, M. D. Nucl. Technol.; 14: No. 3, 240-6(Jun 1972).

High temperature gas-cooled reactors (HTGR's) employ fuel elements which are separated by graphite from the coolant stream. Pressure differentials induced by turbulent flow along the coolant channel length of the fuel assembly can cause transverse flow of the gas through the graphite sleeve. Such transverse flow could transfer fission products from broken fuel particles into the main coolant stream. A mathematical analysis shows that the thickness of the annular gap between the fuel element and the graphite sleeve is an important factor that controls fission product transport by this mechanism. The data obtained from experiments performed in a high temperature, pressurized helium loop correlate satisfactorily with this analysis, and an estimate of cesium release to the coolant via this mechanism is made for the Ft. St. Vrain reactor. (8 references) (auth)

32789 STEAM GENERATOR VESSEL PRESSURES RESULTING FROM A SODIUM-WATER REACTION: A COMPUTER ANALYSIS WITH THE SWEAR CODE. Greene, David A. (General Electric Co., Sunnyvale, Calif.). Nucl. Technol.; 14: No. 3, 218-31(Jun 1972).

A computer code was written to predict pressure on the shell side of a steam generator during a large scale sodium/water reaction resulting from the instantaneous full bore rupture of a water tube. A typical pressure transient has two main features. An initial pressure spike is followed by a secondary pressure pulse whose amplitude is a function of the inertia forces governing the growth of the hydrogen bubble. Unlike the primary pressure spike which lasts a very short time, the secondary pulse can last for a long time and must be considered a steady state pressure acting on the shell. Rupture discs under sodium may not provide an effective means of relieving the secondary pressure pulse unless the sodium/water reaction occurs close enough to the disc to cause its rapid failure. It is concluded that both superheater and evaporator units of a reference steam generator design can withstand the pressure transient associated with the sodium/water reaction resulting from a guillotine failure of a single heat transfer tube. (18 references) (auth)

32790 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR. (to Babcock and Wilcox Co.). British Patent 1,269,523. 6 Apr 1972. Priority date 25 Apr 1968, United States.

REACTORS, PRESSURIZED WATER—cooling system for, vanes for imparting swirl to coolant in primary (H.D.R.)

Fuels and Fuel Elements

Refer also to abstracts 31075, 31392, and 31627.

32791 (GEAP-10028-41) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Forty-First Quarterly Report, November 1971–January 1972. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Feb 1972. Contract AT(04-3)-189. 155p. Dep. NTIS.

EXPERIMENTAL BREEDER REACTOR-II—fuel irradiation testing in, status of mixed oxide
FAST CERAMIC REACTOR—fuel elements for, development during November to January 1971
—core for, design and kinetics analysis of
—safety of, transient overpower and loss of flow effects on
INCOLOY 800—radiation effects on swelling and mechanical properties of, fast neutron, (E)
LIQUID METAL FAST BREEDER REACTORS—fuel elements for, development of stainless steel clad plutonium oxide (PuO_2)–uranium oxide (UO_2)
NEUTRONS, FAST—effects on Incoloy 800 and stainless steels, (E)
PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, radiation effects testing of fuels of
—PuO_2–UO_2, properties of fuels of, mechanical, physical, and thermal, (E)
REACTOR FUEL ELEMENTS—performance of defected mixed oxide, in flowing sodium, (E)
—cladding for mixed oxide fast, development and testing of stainless steel
—radiation effects testing of mixed oxide fast
STAINLESS STEEL—radiation effects on swelling and mechanical properties of Type 304, Type 316, Type 321, and Type 347, fast neutron, (E) (H.D.R.)

32792 (NP-19258) UTILIZATION OF PLUTONIUM IN BWR'S EEI/GE RP-72 PHASE II. Informal Progress Letter. Crowther, R. L. (General Electric Co., San Jose, Calif. Nuclear Energy Div.). Oct 1971. 5p.

Analysis of the Oyster Creek reactor emergency core cooling has indicated that, although the prototypical Pu recycle assemblies can be designed to safely produce power, the ECCS margin is not as great as in plants which utilize jet pumps and as a result irradiation would be more optimum in alternate BWR's. Alternate BWR irradiation sites with greater ECCS margin are being evaluated. Improved physical models were developed for prediction of the thermal-mechanical behavior of PuO_2 microspheres in fast transients. Irradiation of the Big Rock EEI fuel rods continued with no problems and the burnup status of these rods is reported. The 48 EEI fuel rods that are awaiting assembly were used in the AEC PIP/ISE program. NaI(Tl) and Gd(Li) measurements were compared and preliminary conclusions as to precision of NDT techniques were developed. (auth)

32793 FAST BREEDER REACTOR BURN-UP AND FISSION YIELD MEASUREMENT PROGRAMME IN THE USA. Maeck, W. J. (Idaho Nuclear Corp., Idaho Falls). pp 31-7 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

The principal USAEC laboratories participating in this program are the Argonne National Laboratory, Los Alamos Scientific Laboratory, and Allied Chemical Corporation, Idaho Falls. The major burn-up measurement technique being investigated is destructive chemical analysis for selected fission product nuclides. The program emphasis is to obtain accurate fast reactor fission yields and capture-to-fission ratios for the major isotopes of uranium, neptunium, plutonium and americium; to measure the fast reactor capture cross sections for those stable fission products which show promise as burn-up monitors; and to improve the chemical separation and measurement methodology for accurate burn-up analysis. (4 references) (auth)

32794 COMPARISON OF EXPERIMENTAL AND THEORETICAL DETERMINATIONS OF BURN-UP AND ISOTOPIC CONTENT OF IRRADIATED FUEL IN THERMAL GAS-COOLED REACTORS. Collins, D. A.; Griggs, C. F.; McGhee, J.; Thorpe, G. (United Kingdom Atomic Energy Authority, Windscale, Eng.). pp 75-83 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

During the operation of the Windscale Advanced Gas Cooled Reactor the methods of determining fuel rating and burn-up have been developed considerably. The difficulties encountered and the changes made are described, and the current method is shown to give satisfactory agreement with analyses of fuel pellets for the fission product ^{148}Nd. The isotopic content of irradiated fuel shows good agreement with calculation, this result giving confidence in the reactor physics methods used and their application to commercial AGRs. The burn-up estimated from the isotopic changes is also in good agreement with the calorimetric method of estimating burn-up. (0 references) (auth)

32795 HEAVY ISOTOPE AND BURN-UP DETERMINATION IN SGHWR FUEL. Fox, W. N. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). pp 85-90 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

The irradiation history of specific fuel clusters may be calculated in a relatively direct manner owing to the slow variation in rating distributions, which results from the absence of partially inserted absorbers during burn-up; long-term reactivity changes are controlled instead by moderator poisons. A comparison between measured and calculated heavy isotope concentrations in fuel irradiated to different levels in the Winfrith Steam Generating Heavy Water Reactor was intended primarily to confirm the adequacy of the lattice codes used for the design of commercial reactors. The use of a lattice code which represents in detail the physical processes occurring and is in use for a variety of systems, both gas- and water-cooled, allows additionally an integral test of the nuclear data to be made. The irradiation level is determined by measurement of the change in ^{235}U to ^{238}U heavy isotope ratio. This determination should be reliable since archived unirradiated material is available, and uncertainty in cross-section data is limited to the uncertainty in ^{235}U captures, which represent only 16% of the total absorptions in ^{235}U. The results show excellent agreement between measurement and calculation for the principal uranium and plutonium isotope ratios. (4 references) (auth)

Auxiliary Systems and Engineered Safeguards

32796 (WCAP-7817) SEISMIC TESTING OF ELECTRICAL AND CONTROL EQUIPMENT. Vogeding, E. L. (Westinghouse Electric Corp., Pittsburgh, Pa.). Dec 1971. 49p.

In a nuclear power plant, electrical and control equipment which initiates reactor trips, actuates safeguards systems and/or monitors radioactive releases from the plant must be capable of performing its functions during and after an earthquake that has occurred at the plant site. To demonstrate the ability of this equipment to perform under earthquake conditions, selected types of this essential equipment representative of all protection and safeguards circuits and equipment were subjected to vibration tests which simulated the seismic conditions for the "low seismic" class of plants. During the tests, equipment operation was monitored to prove proper performance of functions. The results show that there were no electrical malfunctions. Based on these results, it is concluded that the equipment will perform their design functions during, as well as following, a "low seismic" earthquake. (auth)

Operation and Economics

32797 (ANL/ES-12) TREATMENT OF COOLING WATERS WITH CHLORINE. Draley, Joseph E. (Argonne National Lab., Ill.). Feb 1972. Contract W-31-109-eng-38. 11p. Dep. NTIS.

The use of chlorine as a defouling agent in power plants requires assurance that aquatic biota will not be harmed. Three requirements are identified: (1) establishment of standards, (2) development of means of predicting the levels of active chlorine species at points of discharge, and (3) monitoring power plant effluents at points of discharge. Various aspects of the problem are considered. (10 references) (auth)

32798 (CONF-720415-1) USES OF WASTE HEAT. Beall, S. W. Jr. (Oak Ridge National Lab., Tenn.). [1969]. 9p. Dep. NTIS. ASME, New York, N. Y. $2.00.

From American Society for Engineering Education meeting; Knoxville, TN. (5 Apr 1972).

A variety of possible applications for the warm water or waste heat being discharged from steam-electric power stations is discussed. The results of studies on heating and cooling cities, recycling of sewage and waste waters, and heating and cooling of enclosed environmental structures for the cultivation of plants, poultry, and animals are summarized. The current U. S. work in open-field irrigation and soil heating with warm water and in aquaculture are also reviewed. A combination of several uses could consume, or dispose of, all heat from a large power station, making a conventional cooling installation unnecessary. 8 references. (auth)

32799 (ORNL-TM-3709) USER'S MANUAL FOR REFCO, A DISCOUNTED CASH FLOW CODE FOR CALCULATING NUCLEAR FUEL CYCLE COSTS. Salmon, Royes (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 73p. Dep. NTIS.

The computer code REFCO, which calculates nuclear fuel cycle costs by a discounted cash flow procedure with continuous discounting, was described in ORNL-4695. As originally presented, the code could be used only for light water reactors operating on the enriched uranium fuel cycle. The code was revised so that it can be applied to fast breeder reactors and light water reactors using plutonium recycle. Other minor changes were made to increase the usefulness of the code. The preparation of 'nput data is described in detail, and the input and results of five example problems are discussed. Also included are a FORTRAN listing of the new version of the code and a listing of the computer output for the example problems. (auth)

32800 UTILIZATION OF WASTE HEAT FROM NUCLEAR POWER PLANTS IN THE PURIFICATION AND PROCESSING OF WASTE WATER. Doetsch, E.; Merkel, W.; Friedrichs, H. A. Wasser, Luft Betr.; 14: 23-5(1971). (In German).

The feasibility of utilizing the waste heat of nuclear power plants for the methods of waste-water purification, treatment of sewage sludge, and processing of waste water for re-use is discussed. Nuclear heat seems particularly useful in connection with the sewage sludge treatment (thermal conditioning, drying, combustion). The re-use of waste water as drinking water or service water represents a way out of the water scarcity in many regions. Distillation methods are becoming economical by using nuclear heat. Similar to seawater desalination, compound plants will be capable of satisfying the power and freshwater needs of a region and simultaneously eliminating the waste water. The condensate may be processed so as to yield freshwater of different quality grades. A dual supply system for service water as well as for drinking water may improve the economy of such a plant. (INIS)

32801 METHOD OF CHARGING A GAS-COOLED HIGH TEMPERATURE NUCLEAR REACTOR. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,269,804. 6 Apr 1972. Priority date 8 May 1968, Germany.

REACTORS, PEBBLE BED—fueling method for, achievement
  of uniform fuel burnup by (H.D.R.)

32802 ECONOMIC PROSPECTS OF NUCLEAR ENERGY. Krymm, Rurik (A.I.E.A., Vienna). Ing. Nucl.; 12: No. 1, 28-34(1971). (In Italian).

At the beginning of the present decade it was anticipated that world nuclear power would rise by a factor of 15, or from 24,000 MW to about 330,000 MW. Predictions are made for reactors of proven types, based on current costs and the expected effects of inflation. Figures are given for uranium costs, conversion, enrichment, and fabrication costs, and other pertinent economic factors for BWR and HWR reactors. Anticipated installed power for 1975 and 1980, nuclear and electric, is presented for the seven geographical areas of the world, and some long-range predictions are made for the post-1980 era. (K.S.W.)

32803 END OF DECADE DOUBLING. Olds, F. C. Power Eng.; 76: No. 4, 44-5(Apr 1972).

The imbalance between how fast the U. S. electricity demand grows and the ability to provide new generating capacity is examined. The ability of the U. S. to produce the fossil fuels needed to meet energy demands is discussed. (H.D.R.)

Safety and Siting

32804 (AI-AEC-13020) LMFBR SAFETY PROGRAMS. Quarterly Technical Progress Report, October-December 1971. (Atomics International, Canoga Park, Calif.). 15 Feb 1972. Contract AT(04-3)-824 34p. Dep. NTIS.

LIQUID METAL FAST BREEDER REACTOR—safety research
  on, summary of October to December 1971
  —coolant combustion accidents in, test program for release
    and transport of aerosols and energy from liquid sodium
  —coolant jet discharge in, analysis of hydrodynamics for
    pipe rupture actuated liquid sodium
REACTOR SAFETY—coolant combustion and jet discharge in
  liquid metal fast breeder reactor accidents, analysis of
  liquid sodium
SODIUM—combustion in reactor accidents, release and trans-
  port of aerosols and energy from
  —discharge in reactor accidents, analysis of hydrodynamics
    for jet, (D.C.C.)

32805 (COO-2160-3) INVESTIGATION OF THE INFLUENCE OF THERMAL DISCHARGE FROM LARGE ELECTRIC POWER STATION ON THE BIOLOGY AND NEAR-SHORE CIR-

CULATION OF LAKE MICHIGAN. PART A. BIOLOGY. Quarterly Report, January 1, 1972–March 31, 1972. Beeton, A. M. (Wisconsin Univ., Milwaukee. Center for Great Lakes Studies). 7 Apr 1972. 1p. Dep. NTIS.

32806 (KFK–1501) INVESTIGATION OF INDIVIDUAL AND POPULATION DISPERSION FACTORS FOR POSSIBLE REACTOR LOCATIONS FROM KARLSRUHE (360 KILOMETERS DISTRIBUTION) TO MANNHEIM (430 KILOMETERS DISTRIBUTION). Bayer, A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Dec 1971. 63p. (In German). Dep. NTIS (U. S. Sales Only).

Under the aspect of atmospheric dispersion the Upper Rhine between Karlsruhe and Mannheim is considered as an appropriate district for reactor sites. Sources with heights of H = 0 m, 50 m, and 100 m are placed along the river at a distance of 1 km. The individual and population dispersion factors dependent on the direction of the wind are calculated for normal weather conditions as well as inversion, taking into account short, prolonged and continuous release. The results are presented and discussed with emphasis on the two sites of Philippsburg and Ludwigshafen–BASF. It is shown that the population dispersion factor of Ludwigshafen–BASF is about 10 times higher that that of Philippsburg. It is proposed to use the maximum dispersion factor resulting from inversion weather and prolonged release to characterize reactor sites. (30 references) (auth)

32807 (ORNL-tr–2591) BURNOUT TESTS IN THE SCOPE OF TECHNICAL SAFETY INVESTIGATIONS. Mayinger, F.; Hein, D.; Kastner, W. Translated for Oak Ridge National Lab., Tenn., from Nuclex 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. 12p. (CONF-691018–5). Dep. NTIS.

Burnout tests were made on four-rod and nine-rod clusters under the operating conditions prevailing in boiling water and pressurized water reactors to study the influence of radial heat flux distribution and the critical heat flux under conditions of power and mass flow transients. Radial flux distribution raises the question of an accurate subchannel analysis. During fast power transients the maximum heat flux is a function of the bundle geometry. All transient tests showed that critical heat fluxes are not lower under these conditions than those to be expected under corresponding quasi steady-state conditions. 8 references. (auth)

32808 (WCAP–7808(Vol.1)) PERFORMANCE OF ZIRCALOY CLAD FUEL RODS DURING A SIMULATED LOSS-OF-COOLANT ACCIDENT: MULTI-ROD BURST TESTS. VOLUME I. TEST SET-UP AND RESULTS. Schreiber, R. E.; Lange, R. A.; McKown, D. L. (Westinghouse Electric Corp., Pittsburgh, Pa.). Dec 1971. 125p.

Twelve transient burst tests were conducted. Each test was composed of 64 Zircaloy-4 clad rods (three feet long by 0.422 inch O.D.) in a square array and standard pitch (0.563 inch). ZrO_2 coated (nominal 5 mils), resistance heated, and filled with Al_2O_3 pellets. Fourteen rods in the center 4 × 4 were pressurized; two were unpressurized and unheated to represent rod cluster control (RCC)thimbles. The two surrounding rows of guard rods, heated but unpressurized, provide the appropriate thermal environment. The bursts produced during the transient were randomly distributed in time and location, thus demonstrating that acceptable flow restriction would result. Detailed analysis of flow blockage and correlation with temperature, heating rate, and pressure are summarized in Volume II. (auth)

32809 (WCAP–7808(Vol.2)) PERFORMANCE OF ZIRCALOY CLAD FUEL RODS DURING A SIMULATED LOSS-OF-COOLANT ACCIDENT: MULTI-ROD BURST TESTS. VOLUME II. ANALYSIS OF RESULTS. Caso, C. L. (Westinghouse Electric Corp., Pittsburgh, Pa.). Dec 1971. 77p.

Based on the results of the Multi-Rod Burst Test (MRBT), peak clad temperature increases due to changes in fuel rod geometry in Westinghouse PWR cores following a loss-of-coolant accident are not expected to exceed 100°F. Analysis of the geometry distortion observed in the Multi-Rod Burst Test (MRBT) indicates that the fuel rods burst in a staggered manner thus precluding the occurrence of an extensive flow area blockage in the core during a loss of coolant accident. The regression line of the values of the maximum average (assembly-wise) flow area blockage on the heating rate and the initial pressure shows that the highest flow area blockage is 50 percent and occurs at low heating rates (<5°F/sec) and low pressure (200 psi). The corresponding assembly flow redistribution at the blockage location results in a reduction of 25 percent in the assembly mass flow rate when compared to the no blockage case. The effect of flow redistribution and rod geometry distortion on the clad temperature transient is determined by analyzing the three-dimensional temperature distribution in the hottest fuel rod. The reduction in coolant flow in the channels surrounding this rod is accounted for by correspondingly adjusting the rod surface convective heat transfer coefficients. No heat transfer is considered for the portion of the fuel rod in contact with the adjacent rods. The analysis of the temperature transient of a PWR reactor fuel rod with a no blockage peak clad temperature of 2300°F, yields an increase of 70°F in peak clad temperature when the worst rod geometry observed in the MRBT is considered. (auth)

32810 ANALYTICAL METHOD FOR CALCULATING STEADY-STATE FISSION GAS RELEASE. Baston, V. F.; McFadden, J. H.; Yuill, W. A. (Aerojet Nuclear Co., Idaho Falls, Idaho). Nucl. Technol.; 14: No. 3, 247-56(Jun 1972).

An analytical method based on a steady-state release model is presented for calculating noble gas and iodine release to the fuel-cladding gap of fuel pins in a nuclear reactor operating at steady-state conditions. This method, which employs fission gas capsule data and conservative assumptions (assumptions that result in prediction of maximum release), can be used in reactor safety analysis to predict the fission gases that could be available for release in the event of cladding failure and the pressure exerted by the fission gases on the inside of the cladding during reactor operation. (22 references) (auth)

32811 NUCLEAR SAFETY. VOLUME 13, NUMBER 3. Cottrell, Wm. B.; Jordan, W. H.; Blakely, J. P. One of Four Technical Progress Reviews Published for the Technical Information Center, USAEC. Oak Ridge, Tenn.; Oak Ridge National Laboratory (May–Jun 1972). 94p. GPO $0.60.

For abstracts of individual papers see: 32812, 32912, and 32913.

32812 DETECTION OF FAILED FUEL ELEMENTS. Groos, Ekkehard (Kernforschungsanlage, Juelich, Ger.). Nucl. Safety; 13: No. 3, 220-4(May–Jun 1972).

Safety, versatility, and economy of a high-temperature pebble-bed reactor could be improved if fuel elements with undesired high fission-product release were removed from the core loading. However, measurements for detecting these leaky elements can only be performed during the intercycling periods when a fuel element is out of the core. The common difficulty encountered in the three detection methods investigated was the short time available for measurements, 7 to 24 sec, depending on the rate of circulation of the fuel elements. A fission-gas annealing method proved applicable, and a technique using a laser beam for removing small amounts of graphite for beta counting is being examined. 15 references. (auth)

Commercial Power Reactors

32813 POWER REACTORS 1972. Nucl. Eng. Int.; 17: No. 191, 306-34(Apr 1970).

The world's power reactors are presented in tabular form. The information includes details of utilities, operators and contractors, technical data, progress schedules and a list of planned stations. (UK)

Control and Instrumentation

32814 (DOCKET-50029–176) YANKEE NUCLEAR POWER STATION. Core Mechanical Design, Proposed Change 98. (Yankee Atomic Electric Co., Westboro, Mass.). 26 Apr 1972. 2p. Dep. NTIS.

Authorization is requested to install two hafnium–Zircaloy unitized control rod-follower assemblies into Core X. The assemblies would replace two distorted Inconel clad AgInCd–Zircaloy assemblies. (H.D.R.)

32815 (DOCKET-50219–181) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Core Spray System Water Hammer Study, Supplement 1. (Jersey Central Power and Light Co., Morristown, N. J.). 24 Apr 1972. 18p. Dep. NTIS.

32816 (DOCKET-50237–229) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Switching Problem on Bus 28 Revealed Several Pieces of Equipment Inoperable. (Commonwealth Edison Co., Chicago, Ill.). 25 Apr 1972. 3p. (DOCKET-50249–132). Dep. NTIS.

32817 (DOCKET-50254–87) QUAD-CITIES STATION, UNITS 1 AND 2. Error in Jumper Placement on Emergency Diesel Generators. (Commonwealth Edison Co., Cordova, Ill.). 27 Apr 1972. 1p. (DOCKET-50265–68). Dep. NTIS.

32818 (DOCKET-50263–119) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Three Conditions Which Have

Interfered With Operation. (Northern States Power Co., Minneapolis, Minn.). 25 Apr 1972. 3p. Dep. NTIS.

Three incidents of non-compliance with the technical specifications for the Monticello Power Reactor are reported. The incidents involved malfunctions of (1) the service water system regulating valve, (2) the high pressure coolant injection system (HPCI) outboard steam isolation valve, and (3) the HPCI steam line-high area temperature switch. (H.D.R.)

32819 (DOCKET-50265-67) QUAD-CITIES STATION, UNIT 2. Riser Obstruction Discovered April 29, 1972. (Commonwealth Edison Co., Cordova, Ill.). 1 May 1972. 1p. Dep. NTIS.

32820 (DOCKET-50321-41) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Summary of the Detection and Evaluation of Ultrasonic Indications. (Southwest Research Inst., San Antonio, Tex.). Jan 1972. 179p. Dep. NTIS.

For Georgia Power Co., Atlanta.

A preservice ultrasonic inspection of the Edwin I. Hatch Nuclear Plant, Unit 1 pressure vessel indicated possible flaws in two recirculation inlet nozzle-to-shell welds. A series of investigations conducted to evaluate the nature and significance of the flaws is described. The evaluation concludes that the vessel is safe to operate in its present condition and that the flaws represent no impairment to the structural integrity of the vessel. (H.D.R.)

Operation and Economics

32821 (AAEC/LIB/Bib-327) CAPITAL COSTS FOR NUCLEAR POWER PLANTS. A Bibliography. Literature Search Covers the Period 1962-1971. Geue, Jean (comp.) (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb 1972. 60p. Dep. NTIS (U. S. Sales Only).

One hundred and twenty-two references on construction and other capital costs for nuclear power plants, and two hundred and ten references on capital costs considered as one of many factors in the economics of nuclear power plants are listed. Arrangement is chronological and alphabetical by author within each year. The period covered in the abstracting journals is 1962-1971 and reference is made to an abstract for each citation. (Australia)

32822 (DOCKET-1155-167) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report for February 1972. (Dairyland Power Cooperative, La Crosse, Wis.). Feb 1972. Contract AT(11-1)-851. 26p. (DPC-851-40). Dep. NTIS.

32823 (DOCKET-50003-109) INDIAN POINT STATION, UNIT 1. Main Steam Stop Valve Failed to Close Because of Worn Gear. (Consolidated Edison Co. of New York, Inc., New York). 2 May 1972. 2p. Dep. NTIS.

32824 (DOCKET-50003-110) INDIAN POINT STATION, UNIT 1. Snubber Piston-Seal Shaft Connecting Pin Failure. (Consolidated Edison Co. of New York, Inc., New York). 10 May 1972. 3p. Dep. NTIS.

The failure of a control rod snubber piston-seal connecting pin is described. Examination of the failed pin and corrective actions are described. (D.C.C.)

32825 (DOCKET-50016-156) ENRICO FERMI ATOMIC POWER PLANT. Report for January 1972. (Power Reacor Development Co., Detroit, Mich.). 2 May 1972. 16p. (PRDC-EF-101). Dep. NTIS.

32826 (DOCKET-50029-177) YANKEE NUCLEAR POWER STATION. Operations Report No. 135, March 1972. (Yankee Atomic Electric Co., Westboro, Mass.). 28 Apr 1972. 11p. Dep. NTIS.

32827 (DOCKET-50029-180) YANKEE NUCLEAR POWER STATION. Technical Specifications, Proposed Change 100. (Yankee Atomic Electric Co., Westboro, Mass.). 16 May 1972. 5p. Dep. NTIS.

Revised technical specifications are presented concerning reduced power level and modified shutdown requirements due to a malfunctioning control rod. (D.C.C.)

32828 (DOCKET-50146-107) SAXTON NUCLEAR EXPERIMENTAL REACTOR PROJECT. Operating Experience Report, December 1970-August 1971, Revised Pages. (Saxton Nuclear Experimental Corp., Pa.). 27 Apr 1972. 9p. Dep. NTIS.

32829 (DOCKET-50146-108) SAXTON NUCLEAR EXPERIMENTAL REACTOR PROJECT. Operating Experience Report, Semiannual, September 1, 1971-February 29, 1972. (Saxton Nuclear Experimental Corp., Pa.). 27 Apr 1972. 46p. Dep. NTIS.

32830 (DOCKET-50155-111) BIG ROCK POINT NUCLEAR PLANT. Failure of Liquid Poison System Explosive Valve to Operate on Test. (Consumers Power Co., Jackson, Mich.). 11 May 1972. 4p. Dep. NTIS.

32831 (DOCKET-50219-183) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Authority to Load but not Operate in Configuration of Facility Change Request 2. (Division of Reactor Licensing (AEC), Washington, D. C.). 25 Apr 1972. 2p. Dep. NTIS.

32832 (DOCKET-50255-82) PALISADES PLANT. Malfunctions Involving Motor Packages of Control Rod Drive Mechanisms. (Consumers Power Co., Jackson, Mich.). 4 May 1972. 2p. Dep. NTIS.

32833 (DOCKET-50265-70) QUAD-CITIES STATION, UNIT 2. Heat Tracing on Suction Piping Found to be Inoperable. (Commonwealth Edison Co., Cordova, Ill.). 29 Apr 1972. 2p. Dep. NTIS.

32834 (DOCKET-50265-71) QUAD-CITIES STATION, UNIT 2. Discovery and Removal of Heliarc Welding Outfit in a Jet Pump Riser. (Commonwealth Edison Co., Cordova, Ill.). 8 May 1972. 2p. Dep. NTIS.

32835 (DOCKET-50301-55) POINT BEACH NUCLEAR PLANT, UNIT 2. Order Extending Facility Operating License Expiration Date to November 16, 1972. (Division of Reactor Licensing (AEC), Washington, D. C.). 27 Apr 1972. 3p. Dep. NTIS.

32836 GROWTH PATTERNS IN GENERATION. Schuster, Ray. Power Eng.: 76: No. 4, 32-7(Apr 1972).

The utility plans for new generating capacity through 1980 are analyzed. The type and amount of generating capacity scheduled to be added, the utilities planning the greatest expansions, and the consulting firms and manufacturers most heavily involved are examined. (H.D.R.)

Safety and Siting

32837 (DOCKET-50010-107) DRESDEN NUCLEAR POWER STATION, UNIT 1. Report on ECCS Conformance to AEC Interim Acceptance Criteria. (Commonwealth Edison Co., Chicago, Ill.). 27 Jan 1972. 17p. Dep. NTIS.

32838 (DOCKET-50029-178) YANKEE ATOMIC POWER STATION. Final Safety Analysis Report, Change 98. (Division of Reactor Licensing (AEC), Washington, D. C.). 2 May 1972. 2p. Dep. NTIS.

Revised technical specifications are presented concerning the use of two hafnium-Zircaloy control rod assemblies in Core 10. (D.C.C.)

32839 (DOCKET-50029-179) YANKEE NUCLEAR POWER STATION. Technical Specifications, Proposed Change 99. (Division of Reactor Licensing (AEC), Washington, D. C.). 11 May 1971. 5p. Dep. NTIS.

Revised technical specifications are presented concerning the boron concentration in the primary cooling system. (D.C.C.)

32840 (DOCKET-50155-110) BIG ROCK POINT NUCLEAR PLANT. Technical Specifications, Change 30. (Atomic Energy Commission, Washington, D. C.). 4 May 1972. 14p. Dep. NTIS.

Revised technical specifications are presented concerning inservice inspection procedures and requirements for the pressure vessel, heat exchangers, and piping associated with the primary cooling system. (D.C.C.)

32841 (DOCKET-50219-182) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Safety Valve Seat Bushing Cracks. (Jersey Central Power and Light Co., Morristown, N. J.). 1 May 1972. 3p. Dep. NTIS.

32842 (DOCKET-50220-92) NINE MILE POINT NUCLEAR STATION, UNIT 1. New System for Unidentified Leak-Rate Detection. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 4 May 1972. 5p. Dep. NTIS.

32843 (DOCKET-50244-97) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Average Release Rate of ^{131}I 1.3 Times Technical Specifications Limit. (Rochester Gas and Electric Corp., N. Y.). 28 Apr 1972. 2p. Dep. NTIS.

32844 (DOCKET-50244-98) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Review of Fuel Rod Integrity at the Ginna Reactor. (Rochester Gas and Electric Corp., N. Y.). 24 Apr 1972. 34p. (WCAP-7703(Rev.)). Dep. NTIS.

32845 (DOCKET-50245-126) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Three Abnormal Occurrences Because Switch Setpoint Was too Close to Allowed Value. (Millstone Point Co., Hartford, Conn.). 20 Apr 1972. 2p. Dep. NTIS.

32846 (DOCKET-50245-127) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Evaluation of Blowdown Forces Created by the Relief Valve Discharge Lines on the Torus Baffles. (Millstone Point Co., Hartford, Conn.). 21 Apr 1972. 2p. Dep. NTIS.

32847 (DOCKET-50245-128) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Supplementary Information Regarding Control of Combustible Gas Concentrations. (Millstone Point Co., Hartford, Conn.). 28 Apr 1972. 15p. Dep. NTIS.

32848 (DOCKET-50249-131) DRESDEN NUCLEAR POWER STATION, UNIT 3. Additional Information to Final Report of Safety Valve Operation Following a Feedwater Transient. (Commonwealth Edison Co., Chicago, Ill.). 26 Apr 1972. 13p. Dep. NTIS.

32849 (DOCKET-50254-88) QUAD-CITIES STATION, UNITS 1 AND 2. Technical Specifications, Appendix B. (Commonwealth Edison Co., Chicago, Ill.). 28 Apr 1972. 26p. (DOCKET-50265-69). Dep. NTIS.

The proposed program for monitoring and evaluating the nonradiological environmental effects of high power testing and emergency operation of Units 1 and 2 of the Quad Cities Nuclear Station is described. (H.D.R.)

32850 (DOCKET-50259-48) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 28. (Tennessee Valley Authority, Chattanooga). 3 May 1972. 75p. (DOCKET-50260-45; DOCKET-50296-42). Dep. NTIS.

Revised design parameters of the Browns Ferry Power Reactor Units 1, 2, and 3 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

32851 (DOCKET-50263-118) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Performance Report for Main Steam Line Flow Elements. (Northern States Power Co., Minneapolis, Minn.). 25 Apr 1972. 7p. Dep. NTIS.

32852 (DOCKET-50267-43) FORT ST. VRAIN NUCLEAR GENERATING STATION. Plan for Continuing Ecological Studies. (Public Service Co. of Colorado, Denver). 11 May 1972. 42p. Dep. NTIS.

32853 (DOCKET-50269-52) OCONEE NUCLEAR STATION, UNIT 1. Documentation of Piping Materials. (Division of Compliance (AEC), Atlanta, Ga. Region II). 20 Apr 1972. 15p. Dep. NTIS.

32854 (DOCKET-50269-53) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 31. (Duke Power Co., Charlotte, N. C.). 5 May 1972. 126p. (DOCKET-50270-42; DOCKET-50287-38). Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects of the reactors. (D.C.C.)

32855 (DOCKET-50270-43) OCONEE NUCLEAR STATION, UNIT 2. Steps Taken With Respect to Items Noted in Letter of February 28, 1972. (Division of Compliance (AEC), Atlanta, Ga. Region II). 14 Apr 1972. 4p. Dep. NTIS.

Additional information is presented concerning the tensile strength of pressure plates for the No. 2 steam generator. (D.C.C.)

32856 (DOCKET-50271-80) VERMONT YANKEE NUCLEAR POWER STATION. Intentions with Regard to Off-Site Monitoring of Direct Gamma Dose. (Vermont Yankee Nuclear Power Corp., Rutland). 28 Apr 1972. 2p. Dep. NTIS.

32857 (DOCKET-50272-27) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Order Extending Completion Dates. (Directorate of Licensing (AEC), Washington, D. C.). 10 May 1972. 2p. (DOCKET-50311-27). Dep. NTIS.

32858 (DOCKET-50277-37) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Amendment 16. (Philadelphia Electric Co., Pa.). 10 May 1972. 304p. (DOCKET-50278-43). Dep. NTIS.

Revised design parameters of the Peach Bottom Power Reactor Units 2 and 3 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

32859 (DOCKET-50285-61) FORT CALHOUN STATION, UNIT 1. Draft Detailed Statement on Environmental Considerations Related to the Proposed Continuation of Construction Permit CPPR-41 and the Proposed Issuance of an Operating License. (Division of Radiological and Environmental Protection (AEC), Washington, D. C.). Apr 1972. 119p. Dep. NTIS.

The environmental aspects of construction and operation of Unit 1 of the Fort Calhoun Nuclear Station are presented. Included are assessments of the effects of normal and accident condition operation on the environment, aesthetic effects of the facility, alternatives to the proposed facility operation, and a cost-benefit analysis. (H.D.R.)

32860 (DOCKET-50285-62) FORT CALHOUN STATION, UNIT 1. Environmental Radioactivity Surveillance Program, Preoperational Report. (Eberline Instrument Corp., Santa Fe, N. Mex. Dept. of Nuclear Sciences). 1971. 27p. Dep. NTIS.

For Omaha Public Power District, Nebr.

32861 (DOCKET-50285-63) FORT CALHOUN STATION, UNIT 1. Notice of Consideration of Issuance of Facility Operating License and Notice of Opportunity for Hearing. (Atomic Energy Commission, Washington, D. C.). 8 May 1972. 6p. Dep. NTIS.

32862 (DOCKET-50285-64) FORT CALHOUN STATION, UNIT 1. Steps Taken to Correct Items of Apparent Noncompliance Listed in Letter of April 6, 1972. (Directorate of Regulatory Operations (AEC), Denver, Colo. Region IV). 9 May 1972. 9p. Dep. NTIS.

Revised information is presented concerning installation procedures for electric cables. (D.C.C.)

32863 (DOCKET-50286-45) INDIAN POINT NUCLEAR GENERATING, UNIT 3. Final Facility Description and Safety Analysis Report, Amendment 17. (Consolidated Edison Co. of New York, Inc., New York). 5 May 1972. 24p. Dep. NTIS.

Revised information is presented concerning auxiliary diesel generators and communications systems. Requested additional data are included concerning the primary cooling system, Class 1 piping systems and structures, engineered safeguards, and radioactive waste disposal systems. (D.C.C.)

32864 (DOCKET-50289-56) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Final Safety Analysis Report, Amendment 26. (Metropolitan Edison Co., Reading, Pa.). 1 May 1972. 93p. Dep. NTIS.

Revised design parameters of the Three Mile Island Nuclear Station, Unit 1 are presented. Also included are responses to USAEC questions concerning the facility. Additional information is provided with reference to a topical report on "Qualification Testing of Protection System Instrumentation." (H.D.R.)

32865 (DOCKET-50293-69) PILGRIM NUCLEAR POWER STATION. Preoperational Environmental Radiation Survey Program. Quarterly Report, October 1-December 31, 1971. (ICN/Tracerlab, Waltham, Mass.). 21 Apr 1972. 19p. Dep. NTIS.

For Boston Edison Co., Mass.

32866 (DOCKET-50293-70) PILGRIM NUCLEAR POWER STATION. Final Environmental Statement. (Division of Reactor Licensing (AEC), Washington, D. C.). 10 May 1972. 186p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Cost-benefit analysis for the reactor is included. (D.C.C.)

32867 (DOCKET-50295-47) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Environmental Report, Additional Information to Supplement 4. (Commonwealth Edison Co., Chicago, Ill.). 24 Apr 1972. 4p. (DOCKET-50304-47). Dep. NTIS.

32868 (DOCKET-50295-48) ZION STATION NUCLEAR POWER PLANT, UNIT 1 AND 2. Steps Taken to Correct Items of Apparent Noncompliance Listed in Letter of March 31, 1972. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 2 May 1972. 9p. (DOCKET-50304-48). Dep. NTIS.

Additional information is presented concerning quality assurance procedures and welding procedures. (D.C.C.)

32869 (DOCKET-50298-31) COOPER NUCLEAR STATION. Final Safety Analysis Report, Amendment 10, Emergency plan. (Nebraska Public Power District, Columbus). 2 May 1972. 170p. Dep. NTIS.

The emergency plan classifies various types of emergencies that may occur, provides for prior planning of necessary corrective actions, and delineates organized functions and responsibilities in order to control and mitigate off normal conditions and to assure maximum protection of the public, station personnel and plant equipment. The emergency procedures under the plan assess the specific type of emergency according to severity, designate responsibilities, outline the course of actions to be taken by the assigned responsible personnel in order to reduce or confine the consequences of any emergency and protect the general public, plant personnel and plant equipment. (auth)

32870 (DOCKET-50302-41) CRYSTAL RIVER NUCLEAR PLANT, UNIT 3. Final Safety Analysis Report, Amendment 19. (Florida Power Corp., St. Petersburg). 19 Apr 1972. 70p. Dep. NTIS.

Revised design parameters and operations aspects of the Crystal River Power Reactor Unit 3 are presented. (D.C.C.)

32871 (DOCKET-50302-42) CRYSTAL RIVER NUCLEAR PLANT, UNIT 3. Final Safety Analysis Report, Amendment 18. (Florida Power Corp., St. Petersburg). 28 Apr 1972. 344p. Dep. NTIS.

Revised and additional data are presented concerning the design parameters and operations aspects of the reactor. (D.C.C.)

32872 (DOCKET-50305-38) KEWAUNEE NUCLEAR POWER PLANT. Environmental Report, Operating License Stage, Amendment 2. (Wisconsin Public Service Corp., Green Bay). 8 May 1972. 46p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

32873 (DOCKET-50305-39) KEWAUNEE NUCLEAR POWER PLANT. Final Safety Analysis Report, Amendment 17. (Wisconsin Public Service Corp., Green Bay). 12 May 1972. 365p. Dep. NTIS.

Revised design parameters of the Kewaunee Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

32874 (DOCKET-50309-56) MAINE YANKEE ATOMIC POWER STATION. Environmental Report, Additions to and Revisions of Supplement. (Maine Yankee Atomic Power Co., Westboro, Mass.). 19 Apr 1972. 36p. Dep. NTIS.

32875 (DOCKET-50309-57) MAINE YANKEE ATOMIC POWER STATION. Draft Detailed Statement on the Environmental Considerations Related to the Proposed Issuance of an Operating License. (Division of Radiological and Environmental Protection (AEC), Washington, D. C.). Apr 1972. 130p. Dep. NTIS.

The environmental consequences of construction and operation of the Maine Yankee Atomic Power Station are discussed. Included are assessments of the environmental impact of both normal and accident condition operation, aesthetic effects of the facility, alternatives to the proposed facility, and a cost-benefit analysis. (H.D.R.)

32876 (DOCKET-50309-58) MAINE YANKEE ATOMIC POWER STATION. Environmental Report, Addenda. (Maine Yankee Atomic Power Co., Westboro, Mass.). 8 Apr 1971. 212p. Dep. NTIS.

Information to supplement and update the October 1970 environmental report for the Maine Yankee Power Reactor is presented. (H.D.R.)

32877 (DOCKET-50312-37) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Activities Which Appear to be in Nonconformance With AEC Requirements During Inspection March 9, 20-24 and April 6, 1972. (Division of Compliance (AEC), Berkeley, Calif. Region V). 4 May 1972. 3p. Dep. NTIS.

Information is requested concerning quality assurance procedures for separating rejected Class 1 pipe flanges, and unacceptable welds in the containment structure liner. (D.C.C.)

32878 (DOCKET-50315-62) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 22. (Indiana and Michigan Power Co., New York). 24 Apr 1972. 20p. (DOCKET-50316-62). Dep. NTIS.

Revised design parameters of the Donald C. Cook Nuclear Plant, Units 1 and 2 are presented. Also included are additional data on the facility requested by the USAEC. (H.D.R.)

32879 (DOCKET-50321-38) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Final Safety Analysis Report, Amendment 14. (Georgia Power Co., Atlanta). 24 Apr 1972. 245p. Dep. NTIS.

Responses to USAEC requests for additional information on the Edwin I. Hatch power reactor, Unit 1 are presented. All responses which make changes or corrections to the original application for a construction permit and operating license are incorporated into the Final Safety Analysis report. (H.D.R.)

32880 (DOCKET-50321-39) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. License Application, Amendment 15. (Georgia Power Co., Atlanta). 25 Apr 1972. 8p. Dep. NTIS.

The application for construction permit and operating license for Unit 1 of the Edwin I. Hatch Nuclear Plant is revised to update the financial data in the original application. (H.D.R.)

32881 (DOCKET-50321-40) EDWIN I. HATCH NUCLEAR PLANT, UNITS 1 AND 2. Environmental Report Supplement, Amendment 1. (Georgia Power Co., Atlanta). 27 Apr 1972. 48p. (DOCKET-50366-27). Dep. NTIS.

32882 (DOCKET-50322-25) SHOREHAM NUCLEAR POWER STATION, UNIT 1. Environmental Report, Construction Permit Stage, Supplement 1. (Long Island Lighting Co., Hicksville, N. Y.). 21 Apr 1972. 135p. Dep. NTIS.

Requested information concerning chemical, radioactive, and thermal discharges from the reactor is presented. Data are also included for the biota of the reactor site. (D.C.C.)

32883 (DOCKET-50329-30) MIDLAND PLANT, UNITS 1 AND 2. Petition for Review of the Licensing Board's Order Denied. (Atomic Energy Commission, Washington, D. C. Atomic Safety and Licensing Appeal Board). 31 Mar 1972. 4p. (DOCKET-50330-29). Dep. NTIS.

32884 (DOCKET-50329-31) MIDLAND PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 19. (Consumers Power Co., Jackson, Mich.). 22 Mar 1972. 75p. (DOCKET-50330-30). Dep. NTIS.

Additional information is presented in response to questions concerning the antitrust review of the proposed Units 1 and 2 of the Midland Nuclear Plant. (H.D.R.)

32885 (DOCKET-50331-33) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report, Amended Application. (Iowa Electric Light and Power Co., Cedar Rapids). 8 May 1972. 177p. Dep. NTIS.

Cost estimates for the Duane Arnold Power Reactor are presented. Financial data on the owners of the reactor are included. The 1970 Annual Reports for the Iowa Electric Light and Power Company and the Central Iowa Power Cooperative are presented. (D.C.C.)

32886 (DOCKET-50331-35) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report. Appendix B, Proposed Technical Specifications. (Iowa Electric Light and Power Co., Cedar Rapids). 1971. 240p. Dep. NTIS.

32887 (DOCKET-50331-36) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report, Amendment 1. (Iowa Electric Light and Power Co., Cedar Rapids). May 1972. 289p. Dep. NTIS.

Requested additional information on the Duane Arnold Power Reactor is presented under the following topics: site; cooling system; containment; control and instrumentation; radioactive waste systems; auxiliary systems; power conversion systems; plant structures and shielding; conduct of operations; safety analysis; pressure integrity of piping; earthquake stress limits for piping systems; and quality assurance program. (D.C.C.)

32888 (DOCKET-50331-37) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report, Volume 1. (Iowa Electric Light and Power Co., Cedar Rapids). 1972. 649p. Dep. NTIS.

Information on the Duane Arnold Power Reactor is presented under the following broad topics: introduction and summary; site and environs; and reactor. (D.C.C.)

32889 (DOCKET-50331-38) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report, Volume 2. (Iowa Electric Light and Power Co., Cedar Rapids). 1972. 449p. Dep. NTIS.

Information on the Duane Arnold Power Reactor is presented under the following broad topics: cooling system; containment; and core standby cooling systems. (D.C.C.)

32890 (DOCKET-50331-39) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report, Volume 3. (Iowa Electric Light and Power Co., Cedar Rapids). 1972. 539p. Dep. NTIS.

Information on the Duane Arnold Power Reactor is presented under the broad topic of control and instrumentation. (D.C.C.)

32891 (DOCKET-50331-40) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report, Volume 4. (Iowa Electric Light and Power Co., Cedar Rapids). 1971. 573p. Dep. NTIS.

Information on design parameters and operations aspects of the Duane Arnold Power Reactor is presented under the following main topics: electrical power systems; radioactive waste systems; auxiliary systems; power conversion systems; plant structures and shielding; and conduct of operations. (D.C.C.)

32892 (DOCKET-50331-41) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report, Volume 5. (Iowa Electric Light and Power Co., Cedar Rapids). 1972. 630p. Dep. NTIS.

Information on the Duane Arnold Power Reactor is presented under the following topics: plant safety systems; pressure integrity of piping and equipment pressure parts; structural design and loading criteria; and quality assurance program. (D.C.C.)

32893 (DOCKET-50331-42) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report, Volume 6. (Iowa Electric Light and Power Co., Cedar Rapids). 1972. 468p. Dep. NTIS.

Information on the Duane Arnold Power Reactor is presented on the following topics: radioactive effluents; protection systems, emergency systems, and control systems; operations aspects; and personnel qualifications. (D.C.C.)

32894 (DOCKET-50331-43) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report, Volume 7. (Iowa Electric Light and Power Co., Cedar Rapids). 1972. 484p. Dep. NTIS.

Requested additional data are presented concerning design parameters and operations aspects of the reactor. The in-service inspection program is described. Site assembly of the pressure vessel is reviewed. Geological data for the reactor site are included. (D.C.C.)

32895 (DOCKET-50331-44) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report, Volume 8. (Iowa Electric Light and Power Co., Cedar Rapids). 1972. 436p. Dep. NTIS.

Revised design parameters of the Duane Arnold Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. Design parameters and stress limits for containment system components are presented. (D.C.C.)

32896 (DOCKET-50331-45) DUANE ARNOLD ENERGY CENTER. Steps Taken to Correct Items of Apparent Nonconformance Noted in Letter April 12, 1972. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 11 May 1972. 6p. Dep. NTIS.

Additional information is presented concerning the handling and storage of recirculation stainless steel pipe. (D.C.C.)

32897 (DOCKET-50335-26) HUTCHINSON ISLAND PLANT, UNIT 1. Environmental Report, Supplement 2. (Florida Power and Light Co.). 15 May 1972. 72p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Meteorological data for the reactor site are included. Information on site biota is presented. (D.C.C.)

32898 (DOCKET-50348-40) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Draft Environmental Statement. (Division of Radiological and Environmental Protection (AEC), Washington, D. C.). May 1972. 208p. (DOCKET-50364-34). Dep. NTIS.

The environmental consequences of construction and operation of Units 1 and 2 of the Joseph M. Farley Nuclear Plant are presented. Included are assessments of the effects of normal and accident condition operation on the environment, aesthetic effects of the facility, alternatives to the proposed facility operation, and a cost-benefit analysis. (H.D.R.)

32899 (DOCKET-50352-24) LIMERICK GENERATING STATION, UNITS 1 AND 2. Errata for Safety Evaluation. ([Philadelphia Electric Co., Pa.]). 24 Apr 1972. 4p. (DOCKET-50353-24). Dep. NTIS.

The postulated design basis control rod drop accident with a bottom entry control rod is discussed. Techniques for analysis of the radiological consequences of such accidents are described, and the effects of modifications in these analysis techniques are examined. (H.D.R.)

32900 (DOCKET-50352-25) LIMERICK GENERATING STATION, UNITS 1 AND 2. Statement of Reasons Supporting Completion of Site Preparation Activities. (Philadelphia Electric Co., Pa.). 3 May 1972. 11p. (DOCKET-50353-25). Dep. NTIS.

32901 (DOCKET-50354-22) NEWBOLD ISLAND NUCLEAR GENERATING STATION, UNITS 1 AND 2. Supplemental Environmental Report, Construction Permit Stage. (Public Service Electric and Gas Co., Newark, N. J.). 25 Apr 1972. 366p. (DOCKET-50355-22). Dep. NTIS.

The environmental impact of construction and operation of Units 1 and 2 of the Newbold Island Nuclear Station is discussed. Included are assessments of the effects of normal and accident condition operation on the environment, aesthetic effects of the facility, alternative sources of electrical power, and a cost-benefit analysis. (H.D.R.)

32902 (DOCKET-50373-19) LA SALLE COUNTY STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 9. (Commonwealth Edison Co., Chicago, Ill.). 15 May 1972. 59p. (DOCKET-50374-19). Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects of the reactors. Requested additional information on the cooling lake flow characteristics is included. (D.C.C.)

32903 (DOCKET-50376-32) AGUIRRE NUCLEAR PLANT, UNIT 1. Preliminary Facility Description and Safety Analysis Report, Amendment 17. (Puerto Rico Water Resources Authority, San Juan). 10 May 1972. 725p. Dep. NTIS.

Revised and additional data on design parameters and operations aspects of the reactor are presented. Geological and seismological data for the reactor site are included. (D.C.C.)

32904 (DOCKET-50382-22) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Preliminary Safety Analysis Report, Amendment 3. (Louisiana Power and Light Co., New Orleans). 5 May 1972. 161p. Dep. NTIS.

Revised design parameters of the Waterford Power Reactor Unit 3 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

32905 (DOCKET-50387-17) SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2. Antitrust Hearing Need Not Be Conducted. (Department of Justice, Washington, D. C. Antitrust Div.). 28 Apr 1972. 9p. (DOCKET-50388-17). Dep. NTIS.

32906 (DOCKET-50390-13) WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. License Application, Amendment 6. (Tennessee Valley Authority, Chattanooga). 3 May 1972. 3p. (DOCKET-50391-13). Dep. NTIS.

Revised cost estimates for construction of the reactors are presented. (D.C.C.)

32907 (DOCKET-50395-18) VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 7. (South Carolina Electric and Gas Co., Columbia). 1 May 1972. 256p. Dep. NTIS.

The results of a design study on an emergency cooling water impoundment for the Virgil C. Summer Nuclear Station are presented. Field and laboratory investigations together with engineering analyses were conducted in connection with the earth retaining elements of the service water pond. Analyses of the proposed embankment designs demonstrate that all of the earth structures will have an adequate safety factor against failure under both the design basis earthquake motions and under sudden drawdown upon loss of Monticello Reservoir. (H.D.R.)

32908 (DOCKET-50400-17) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Amendment 8. (Carolina Power and Light Co., Raleigh, N. C.). 1 May 1972. 503p. (DOCKET-50401-17; DOCKET-50402-17; DOCKET-50403-17). Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects of the Shearon Harris Power Reactor Units 1, 2, 3, and 4. (D.C.C.)

32909 H.R. 13731 AND H.R. 13732, TO AMEND THE ATOMIC ENERGY ACT OF 1954 REGARDING THE LICENSING OF NUCLEAR FACILITIES. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, SECOND SESSION, MARCH 16 AND 17, 1972. PART 1: HEARINGS. Washington, D. C.; Joint Committee on Atomic Energy (1972). 452p. GPO $1.75.

32910 INTERIM NUCLEAR LICENSING. HEARINGS BEFORE THE SUBCOMMITTEE ON FISHERIES AND WILDLIFE CONSERVATION OF THE COMMITTEE ON MERCHANT MARINE AND FISHERIES, HOUSE OF REPRESENTATIVES, NINETY-SECOND CONGRESS, SECOND SESSION ON H.R. 13752, MARCH 22, 24, 27, 1972, SERIAL NO. 92-18. Washington, D. C.; Joint Committee on Atomic Energy (1972). 365p.

32911 NEW PERSPECTIVES ON LOW LEVEL ENVIRONMENTAL RADIATION MONITORING AROUND NUCLEAR FACILITIES. Beck, H. L.; DeCampo, J. A.; Gogolak, C. V.; (and others) (Atomic Energy Commission, New York). Nucl. Technol.; 14: No. 3, 232-9(Jun 1972).

Increases in radiation exposure of less than one mrad per year, due to gaseous effluents from a nuclear facility, can be measured using sensitive high pressure ionization chambers. As a result of the rapidly fluctuating nature of the plume exposure rate contributions compared to the normal background signal increases in exposure due to gaseous effluents can be uniquely distinguished from variations in ambient background. Passive devices such as thermoluminescent and film dosimeters are incapable of routinely measuring perturbations of this magnitude and, moreover, provide no mechanism for identifying the cause of an increase in integrated exposure. Collateral in situ gamma spectrometry was used to verify the natural exposure rate levels, to identify the isotopes in the gaseous effluent, to estimate off-gas holdup times, and to investigate the exposure from ^{16}N in the steam turbines of a boiling water reactor (BWR) plant. (auth)

32912 BALANCING ENVIRONMENTAL IMPACT AND ECONOMIC PROGRESS: THE IMPACT OF THE COURTS. Nichols, B. L. Nucl. Safety; 13: No. 3, 209-15(May-Jun 1972).

The National Environmental Policy Act of 1969 (NEPA) not only strengthens previous legislation but, in addition, requires a balancing of the environmental impact and the technical and economic benefits to the public as a whole. The interpretation of NEPA by the U. S. Court of Appeals for the District of Columbia Circuit in the Calvert Cliffs case has had considerable impact on both the U. S. Atomic Energy Commission (AEC) and the electric-power industry. Although the burden on the Commission and industry may seem cumbersome, it is conceivable that the thorough review of all aspects of planned projects required by NEPA may result in a twofold benefit: the reduction of both environmental impact and economic outlay at future nuclear power plants. The implications for the nuclear power industry of environmental legislation and the decision of the court in the Calvert Cliffs case are discussed. 29 references. (auth)

32913 SAFETY-RELATED OCCURRENCES REPORTED IN DECEMBER 1971–JANUARY 1972. Castro, William R. (Comp.). Nucl. Safety; 13: No. 3, 236-8(May-Jun 1972).

Occurrences discussed include failure of a relief valve which pressurized the dry well, exposure of workers to contaminated air, several leaks in small primary-water-sampling heat exchangers, an explosion in a reactor off-gas system, a case of boric acid corrosion of a reactor pressure vessel, and breaks in power-reactor steam pipes. 11 references. (auth)

Propulsion and Auxiliary Power Reactors

Refer also to abstract 31572.

32914 (ANCR-1032) PHASE I TOPICAL REPORT. FLOWING GAS, NON-NUCLEAR EXPERIMENTS ON THE GAS CORE REACTOR. Kunze, J. F.; Suckling, D. H.; Cooper, C. G. (Aerojet Nuclear Co., Idaho Falls, Idaho). Feb 1972. 92p. (NASA-CR-120824). Dep. NTIS.

Flow tests were conducted on models of the gas core (cavity) reactor. Variations in cavity wall and injection configurations were aimed at establishing flow patterns that give a maximum of the nuclear criticality eigenvalue. Correlation with the nuclear effect was made using multigroup diffusion theory normalized by previous benchmark critical experiments. Air was used to simulate the hydrogen propellant in the flow tests, and smoked air or argon or freon to simulate the central nuclear fuel gas. All tests were run in the down-firing direction so that gravitational effects simulated the acceleration effect of a rocket. Results showed that acceptable flow patterns with high volume fraction for the simulated nuclear fuel gas and high flow rate ratios of propellant to fuel can be obtained. Using a "point" injector for the fuel, good flow patterns are obtained by directing the outer gas at high velocity along the cavity wall, using louvered or oblique-angle-honeycomb injection schemes. (auth)

32915 (CONF-701105–, pp 353-65) NERVA NUCLEAR SUBSYSTEM FRICTION-DAMPED LATERAL SUPPORT SYSTEM. Bolton, R. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

The severe environmental and operational requirements for the NERVA engine led to the extensive use of graphite in the lateral structural support system (LSS) of the reactor core assembly. The demanding LSS requirements include the condition that the LSS must limit the radial load on the reactor core between narrow limits while permitting thermal and hydraulic motions. At the same time it must limit or dampen any core dynamic motions which are induced during the various phases of life of a space vehicle. The novel feature in the LSS design is the use of the wear properties of graphite, in particular, the controlled friction properties of graphite, to control and limit the core assembly static and dynamic lateral loads. The evolution of the LSS from those of the early KIWI series reactors to the present design concept is traced. A model of a base excited, Coulomb-damped single degree of freedom system is used to investigate the first mode dynamic response. Den Hartog has found the exact solution to this problem for the case when sliding occurs over each full half-cycle and has limited his attention to only an approximate solution for the case of stop motion, during which the exciting base and the excited mass are locked together for a portion of the cycle. Because of space limitations in the NERVA design, however, the stop motion case is found to be the limiting case dynamically. Dimensionless curves describing the overall motions are presented and used to discuss the role of graphite friction in the LSS design. (auth)

32916 (CONF-701105–, pp 366-71) STEEL-TO-GRAPHITE CONNECTIONS ANALYZED BY FINITE ELEMENT TECHNIQUES FOR USE IN NERVA NOZZLE EXTENSION. de la Garza, W. (Aerojet Nuclear Systems Co., Sacramento, Calif.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

The selection of fibrous reinforced graphite for the NERVA rocket nozzle extension was based on a study of various alternate materials. A major problem in the design of the nozzle extension was the structural analysis of the connection of a graphite flange, heated by hot exhaust gases, to a steel flange, which is simultaneously cooled by liquid hydrogen and heated by nuclear radiation. This type of problem is readily solved by the application of a finite-element program for cylindrically orthotropic solids of revolution. The design of the joint is then an application of the full potential of the finite-element method. The connection is modeled for finite-element stress analysis and an arbitrary temperature distribution, determined by a finite-element thermal analysis, is applied. The objectives for the final design concept were to achieve, as nearly as possible, the smallest principal stresses in the plane of the cross section, and uniform hoop compression. The treatment of the bolts and seals in the finite-element model is described. (auth)

32917 (CONF-701105–, pp 619-40) NERVA DESIGN CRITERIA AND APPLICATION FOR BRITTLE MATERIALS. DeSalvo, G. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.); Lombardo, J. J. (Space Nuclear Propulsion Office (AEC/NASA), Cleveland, Ohio). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

The NERVA method of analysis for brittle materials is described with particular emphasis on fracture mechanics and Weibull techniques. Since there is no well defined separation between brittle and ductile materials, a method of classification to be used in conjunction with this analysis is also presented. This method considers not only the type of material but also its structural application, the environment to which it is subjected, and its sensitivity to crack propagation. A specific example of this design methodology coupled with modern probabilistic techniques leading to high reliability in the initial design is presented. (auth)

32918 (CONF-701105–, pp 658-62) APPLICATION OF MONTE CARLO TECHNIQUES IN STRUCTURAL ANALYSIS FOR A NUCLEAR ROCKET. Zemanick, P. P. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

The application of Monte Carlo techniques in the structural analysis of the NERVA nuclear rocket engine reactor is discussed. This unique application of gaming techniques begins with a statistical description (i.e., mean and standard deviation) of the significant input parameters in the nuclear-thermal-structural analysis chain.

With the assistance of a random number generator, random values can be selected for a complete set of input parameters and a Monte Carlo case can be calculated. From a series of such cases, statistically defined output parameters are obtained. A "weighted" Monte Carlo approach is followed, currently assuming normal distribution throughout but conveniently adaptable to any cumulative density function that available data might support. The convergence to a stable solution within a relatively small number of random trials is graphically demonstrated for representative component stress calculations. (auth)

Control and Instrumentation

32919 (CONF-701105–, pp 342-52) STRUCTURAL DESIGN OF NUCLEAR ROCKET FUEL ELEMENTS. Zemanick, P. P. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Feb 1972.

From Conference on continuum aspects of graphite design; Gatlinburg, Tenn. (9 Nov 1970).

A status report is given on NERVA fuel element analytic techniques, including stress calculations in a complicated stress field by finite element methods, the problem of defining a satisfactory criterion of failure, and the application of state-of-the-art probabilistic techniques in predicting the fuel reliability. The principal causes for stresses in the elements are: high power density; interaction between the fuel matrix and the corrosion resistant carbide coating; and interaction between adjacent elements due to inevitable element-to-element temperature differences. The method of calculating the combined stress field due to these mechanisms and others of less importance is discussed. (auth)

Research and Test Reactors

Refer also to abstracts 32753–32755.

32920 FFTF: THE BREEDER LEADER. Olds, F. C. Power Eng.; 76: No. 4, 40-3(Apr 1972).

The Fast Flux Test Facility (FFTF) program is described, and the role of the FFTF in the U.S. Liquid Metal Fast Breeder Reactor program is examined. (H.D.R.)

Control and Instrumentation

32921 (BNWL–1647) FINAL REPORT ON THE PERFORMANCE OF THE VERTICAL SAFETY RODS AT THE HIGH TEMPERATURE LATTICE TEST REACTOR. Clark, R. G. (Battelle Pacific Northwest Labs., Richland, Wash.). 15 Dec 1971. Contract AT(45-1)-1830. 26p. Dep. NTIS.

Following modifications to the poison blades on the vertical safety rods (VSR) of the High Temperature Lattice Test Reactor, viewing ports were added to the VSR housing and a formal surveillance program was initiated. The operating history of the VSRs during the final 13 months of reactor operation is summarized. (8 references) (H.D.R.)

32922 (BNWL-B–77) STUDY OF MIXING IN A SPECIAL CHANNEL. Schwendiman, L. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 30 Mar 1971. Contract AT-(45-1)-1830. 14p. Dep. NTIS.

An experiment on the diffusion of heat into the coolant flowing through an array of Fast Test Reactor simulated fuel pins is described. The experiment utilizes a soluble tracer, simulating a source of heat, to be injected through a small orifice into a channel in the sub-assembly. The experimental arrangement and results of measurements to determine the degree of tracer mixing in the injection channel are described. (H.D.R.)

32923 COMPUTER ANALYSIS OF GAMMA-RAY SPECTRA OF CIRUS REACTOR PRIMARY COOLANT WATER. Marathe, S. G.; Sahakundu, S. M. (Bhabha Atomic Research Centre, Trombay, India). pp 325-9 of Proceedings of the Chemistry Symposium, 1970. Vol. II. Bombay; Dept. of Atomic Energy (1970).

From Chemistry symposium; Madras, India (25 Nov 1970). See CONF-701148–(Vol.2).

A computer analysis of gamma spectrometric data on radionuclides of CIRUS reactor primary coolant water is discussed. By using a NaI(Tl) scintillation detector connected to a 400-channel analyzer, radionuclides present in small amounts (nc/1) cannot be detected unless the system is sufficiently cooled for a few days until the major contributors are decayed. With the use of computer analysis the quantitative estimation of major radionuclides and detection of those in small amounts, such as ^{51}Cr, ^{59}Fe, ^{65}Zn, ^{91}Sr, ^{103}Ru etc can be successfully achieved within a short time. (auth)

32924 COMPLETION OF THE PEC FUEL ELEMENT PROTOTYPE AT CASACCIA. Ing. Nucl.; 12: No. 1, 12-13(1971). (In Italian).

The first fuel element prototype for the PEC reactor was completed in February. The central portion of the element (total length 3,000 mm) consists of 91 rods (6.8 mm OD) wound helically with a steel wire with a pitch of 160 mm. An upper screen holds 19 rods which contain boron carbide. At the lower end of the element is a special foot. Special loading with UO_2 pellets and some dummy pellets (for reasons of economy) is described. (K.S.W.)

Operation and Economics

32925 (DOCKET-50231–117) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Certification That All Fuel Rods Have Been Removed From Reactor Vessel. (Division of Reactor Licensing (AEC), Washington, D. C.). 9 May 1972. 1p. Dep. NTIS.

Safety and Siting

32926 (CEA-CONF–1954) SUDDEN VAPORIZATION OF LIQUID HYDROGEN IN DIRECT CONTACT WITH WATER. Ewald, Rolf; Perroud, Paul (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Feb 1971. 12p. (In French). (CONF-710811–3). Dep. NTIS (U. S. Sales Only).

From thirteenth international congress of refrigeration; Washington, D. C. (27 Aug 1971).

Safety studies with the High Flux Reactor at Grenoble necessitated experiments with a scale model to simulate the effects produced by rupture of the 30l vessel containing liquid deuterium, which serves as the moderating cell for the cold neutron source. Vacuum insulated glass vessels of variable capacity (25, 100, 250, 500 and 1000cc) filled with liquid hydrogen were placed in a parallelepiped tank filled with water, the opposite walls of this tank being transparent. An explosive device was used to fracture the glass vessels. The formation of gas bubbles was studied cinematographically together with the pressure changes generated in the water. In spite of the rapid vaporization of the hydrogen in the water, no shock wave was generated. (France)

32927 (SC-DC–721235) SURVEY OF SANDIA LABORATORIES' REACTOR FACILITIES. Philbin, J. S. (Sandia Labs., Albuquerque, N. Mex.). [1972]. 18p. (CONF-720421–1). Dep. NTIS.

From Nuclear radiation effects on inertial instruments conference; San Bernardino, CA. (18 Apr 1972).

The Reactor Source Applications Division of Sandia Laboratories, Albuquerque, maintains and operates two pulse reactors and a ^{60}Co Gamma Irradiation Facility for radiation effects testing. The Sandia Pulsed Reactor II (SPR II) is a fast burst reactor which uses 105 kg of unmoderated fuel. The fuel is 93 percent enriched uranium alloyed with 10 weight percent molybdenum. Fully assembled SPR II forms an annular cylinder 8.1 inches in diameter by 8.2 inches in height with a 1.5 inch glory hole cavity in the center. This reactor is capable of producing a fast neutron fluence in the glory hole at the core midplane of 10^{15} nvt with a pulse width of 35 μsec (FWHM). The Annular Core Pulsed Reactor (ACPR) is a heterogeneous pool type reactor whose fuel elements consist of a homogeneous fuel-moderator mixture of uranium and zirconium hydride. Cooling and additional moderation are performed by the pool water. The main feature of the ACPR is the 9-inch diameter dry experiment tube which occupies the central region of the reactor core. The fluence within this cavity on a maximum size pulse is 1.5×10^{15} nvt with a pulse width of 4.7 msec (FWHM). The Gamma Irradiation Facility (GIF) consists of two adjoining radiation cells situated over a 20 foot pool of demineralized water which serves as a storage and shielding medium for the ^{60}Co sources when they are not in use. The irradiation cells are independent; each has its own electric elevator, sources of different strength and geometry, and control switches. (auth)

32928 CRITERIA FOR THE SITING OF A NUCLEAR RESEARCH CENTER. Gaglione, P.; Markovina, A. (Centro Comune di Ricerche Nucleari, Ispra, Italy). Ing. Nucl.; 12: No. 1, 21-7(1971). (In Italian).

The problem of siting of a nuclear research center is discussed from the point of view of population radiological protection under accidental conditions. A planning criterion for the surrounding area, based on the existence of an industrial and an agricultural belt, in addition to an exclusion area, is presented and illustrated. A method for evaluating the receptiveness of a site, under such conditions, is also given. This criterion is applied, for illustration, to the site of C.C.R. – Ispra, where the population growth from the time this center was established, seems to justify the proposed method of planning. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 30720, 31132, 31407, 31408, 31432, 31433, 31435, 31436, 31519, 31557, 31558, 31565, 31566, and 32411.

32929 FACILITY FOR STUDYING RADIAL MIGRATION OF RADIOACTIVE PRODUCTS IN FUEL ELEMENTS. Sukhikh, A. V.; Shashurin, V. K.; Davydov, E. F.; Krapivin, M. I. At. Energ. (USSR); 32: No. 4, 318–19(Apr 1972). (In Russian).

An apparatus devised for studying the transport processes of radioactive products across a fuel element section is basically a mechanism for shifting the sectioned end of the fuel element across the 1-mm collimator opening of a gamma spectrometer with a Ge(Li) detector. An example is given of the ^{137}Cs distribution throughout the face of a 1 mm thick sectioned UC tablet which had attained a temperature of 1,200°C at its center, and 600°C in the stainless steel cladding. The distributions of other fragments: (^{95}Zr + Nb), ^{134}Cs, and ^{106}Rh, were also measured. (K.S.W.)

32930 BEHAVIOUR OF FISSION PRODUCTS IN IRRADIATED CERAMIC NUCLEAR FUEL MATERIALS. Findlay, J. R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 91-100 of Chemical Nuclear Data: Measurements and Applications. /Hurrell, M. L. (ed.). London; Institution of Civil Engineers (1971).

From Conference on chemical nuclear data; Canterbury, England (20 Sep 1971).

The behavior of reactor fuel elements during irradiation is influenced significantly by the build-up of fission products. Some are released from the fuel and some are retained. The mechanisms and rates of emission of short-lived radioactive species from oxide fuels are described. The behavior of the retained fission products, including the gases, is discussed in relation to their effect on fuel stability and fuel chemistry. (20 references) (auth)

32931 IMPROVEMENTS RELATING TO TOOL HEADS. (to Atomic Energy of Canada, Ltd.). British Patent 1,269,238. 6 Apr 1972. Priority date 17 Sep 1968, United States.

MACHINE TOOLS—grinding wheel for remote, method for redressing
PRESSURE VESSELS—seal surfaces on reactor, tool head for remote machining of
REACTORS—pressure vessels for, tool head for remote machining of seal surfaces on (H.D.R.)

32932 IMPROVED FUEL ASSEMBLY SPACER GRID FOR A NUCLEAR REACTOR. (to Combustion Engineering, Inc.). British Patent 1,268,957. 29 Mar 1972. Priority date 24 Jun 1968, United States.

REACTOR FUEL ELEMENTS—spacer grid assemblies for, with Zircaloy grids and Inconel spring ferrules (H.D.R.)

32933 IMPROVEMENTS IN NUCLEAR REACTORS. Rigg, Shephard (to United Kingdom Atomic Energy Authority). British Patent 1,268,356. 29 Mar 1972. Filed 7 Aug 1968.

Reference is made to reactors of the type wherein control is provided by a large number of control elements of low worth, which can be switched into or out of the reactor core without the need for slow and careful movement and without the risk of causing serious reactivity changes. Such reactors will normally possess a degree of inherent self-regulation, that will smooth out the effects of step changes in reactivity. In the system described the control elements take the form of a cylindrical body with a piston head at each end and are movable in guide tubes closed except for coolant flow connections. The pistons provide surfaces to which applied pressures can act to cause movement and damping. The reactor coolant inlet pressure acts directly to assist movement of the control elements after an initial displacement from the position of maximum insertion in the core. (UK)

32934 IMPROVEMENTS IN OR RELATING TO COOLING GAS CIRCULATORS FOR NUCLEAR REACTOR PLANTS. Cairns, Walter John; Fraser, William Milton (to James Howden and Co. Ltd.). British Patent 1,268,950. 29 Mar 1972. Filed 14 Nov 1969.

The motor drive shaft for the blower of gas circulators normally runs in oil lubricated bearing devices at its inner and outer ends, and there is a risk of oil passing into the reactor pressure vessel and contaminating the gas in the coolant circuit, with possible serious consequences. The chief object of the arrangement described is to obviate or reduce the risk of ingress of contaminating oil from the motor housing into the cooling circuit. The outer bearing is oil or water lubricated and the inner bearing is gas lubricated, and the zone in the housing associated with oil lubricant is remote from the cooling circuit. The outer bearing may consist of journal and thrust portions, and these may be combined in a single unit. (UK)

32935 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Williams, Albert Etheridge (to United Kingdom Atomic Energy Authority). British Patent 1,269,210. 6 Apr 1972. Filed 29 Aug 1968.

Reference is made to fuel elements of the type comprising ceramic fuel enclosed in a protective sheath. In reactors operating at high power levels the amount of fuel swelling and gaseous fission product release may be such that even with the use of fuel bodies that provide voidage within the fuel elements radial straining of the sheath can still occur, and as a further expedient to avoid such straining allowance can be made for longitudinal expansion of the fuel, in pellet form, in the sheath. Jamming of the pellets may, however, be a problem. The fuel element described is provided with fixed spacing members dividing the fuel into longitudinal segments, one end at least of each spacer member having low resistance to longitudinal crushing. Fixing of the spacer members against longitudinal movement may be achieved by brazing or crimping. Several forms of spacing members are described. (UK)

32936 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Linning, Davis Lees (to United Kingdom Atomic Energy Authority). British Patent 1,268,186. 22 Mar 1972. Filed 26 Apr 1968.

Reference is made in particular to cluster type fuel elements for use in liquid metal cooled fast breeder reactors, and containing both fissile and fertile fuel in metal-sheathed elements. The element described is claimed to be an improvement on that described in B.P. 1174575 (22 Mar 1967), designed to mitigate the effects of ceramic fuel swelling under irradiation. Both internal and external sheathing are provided, with the fuel disposed therebetween. The fuel member is tubular and a ceramic interlayer is disposed between and directly contacting the fuel and the internal and external sheathing. The interlayer is comprised of a ceramic U compound, either of natural or depleted fissile isotopic abundance, and the fuel is a ceramic compound of Pu or U/Pu. The interlayer may be in pellet form and the fuel may consist of vibro-compacted ceramic particles, or vice versa, or both may be in pellet form. The fuel, in pellet form, may be in two annular portions, with a central annular gap, to provide a fission product reservoir and enable gaseous fission products to pass more easily to a plenum at one end of the fuel member or to venting means, and also to assist in providing voidage for the accommodation of swelling. The fuel density should not exceed 85% maximum theoretical. The interlayers and fuel may be carbides, and a thin, nonfissile, non-fertile compatibility layer may be provided between interlayers and sheathing over at least that region of the fuel zone subjected to maximum burn-up; this layer may comprise magnesia, titania or zirconia. (UK)

32937 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS AND GASEOUS COOLANT THEREFOR. Horsley, Geoffrey Winton; Antill, John Edward (to United Kingdom Atomic Energy Authority). British Patent 1,269,333. 6 Apr 1972. Filed 14 Oct 1968.

In He-gas-cooled reactors in which SiC is used as a fuel coating, mass transport of Si from the coating may be a problem. Thermal dissociation of SiC gives rise to a partial pressure of Si over the carbide and any oxygen present in the coolant will produce a partial pressure of SiO. This may raise the rate of destruction of the SiC to an unacceptable level unless the oxygen content of the coolant is rigidly controlled, and purification from oxygen is likely to be difficult and expensive. In the system proposed the concentration in the coolant of materials that can release oxygen is controlled at a level such that a layer of Si is maintained on the SiC and the partial pressure of SiO over the Si is repressed. A Si layer may be maintained by a partial pressure of an oxidant, such as CO_2 or water vapor, above a level that can be determined experimentally. As examples, for 1000°C the partial pressure of CO_2 or water vapor required is 10^{-2} mm; and at 1200°C 10^{-1} mm. In a He coolant at 50 atm pressure a partial pressure of 10^{-1} mm.

CO_2 or water vapor is equal to 3 ppM by volume and a partial pressure of 10^{-2} mm to 0.3 ppM. (UK)

Reactor Physics and Core Engineering

Physics

Refer also to abstracts 32418 and 32763.

32938 (BNL–16650) APPLICATION OF REACTIVITY WEIGHT FACTORS TO REACTOR TRANSIENTS. Lelouche, G.; Diamond, D.; Levine, M. (Brookhaven National Lab., Upton, N. Y.). Mar 1972. 70p. Dep. NTIS.

Flux-adjoint weighting is used in determining feedback weight factors for reactor transients. The complex geometry of the problem is reduced by defining "equivalent" one- and two-dimensional systems for the three-dimensional system. Weighting factors determined in this manner are applied to analysis of xenon feedback stability and a rod drop accident. (8 references) (H.D.R.)

32939 (COO–3052-1) TIME INTEGRATION METHODS FOR REACTOR KINETICS. da Nobrega, Jose de Anchieta Wanderley; Henry, Allan F. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Dec 1971. Contract AT(11-1)-3052. 121p. (MITNE–136). Dep. NTIS.

Thesis. Submitted by Jose de Anchieta Wanderley da Nobrega.

A technique based on the Padé approximations is applied to the solution of the point kinetics equations. The method consists of treating explicitly the roots of the inhour formula which would make the Padé approximations inaccurate. Also, an analytic method is developed which permits a fast inversion of polynomials of the point kinetics matrix and has direct applicability to the Padé approximations. Results are presented for several cases using various options of the method. It is concluded that the technique provides a fast and accurate computational method for the point kinetics equations. Also, an implicit solution method for the time-dependent multigroup diffusion equations known as the "theta method" is studied. Both the usual method and a variation of it, derived from the precursor integrated equations, are considered. Several properties of both versions of the theta method are demonstrated. An attempt is made to find better integration parameters (thetas) for the method, based on corresponding point kinetics calculations. Calculations are done for several test cases, leading to the conclusion that the improvements obtained are of limited value. 47 references. (auth)

32940 (COO–3052-2) NEW APPROACH TO SOLVING THE MULTIMODE KINETICS EQUATIONS. Turnage, Joe C. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Mar 1972. Contract AT(11-1)-3052. 110p. (MITNE–137). Dep. NTIS.

Thesis.

An investigation is made of a new approach to solving a set of equations (the multimode kinetics equations) which have been obtained by the application of time synthesis to the multigroup neutron diffusion equations. The multimode kinetics equations are cast into the form of the point kinetic equations and successfully solved utilizing the application of an analytic inversion of the matrix $[I-\delta A]$ to both the Padé (2, 0) and "modified" Crank–Nicholson approximations to $\exp[\Delta t[A]]$. 53 references. (auth)

32941 (FEI–246) MEASUREMENT OF THE RATIOS OF RADIATION CAPTURE CROSS SECTION TO FISSION CROSS SECTION FOR ^{235}U AND ^{238}Pu IN THE CENTER OF A FAST REACTOR. Voropaev, A. I.; Dulin, V. A.; Zinov'ev, V. P.; Kazanskii, Yu. A.; Mamontov, V. F.; Sidorov, G. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

The ratio of the average values of the radiation capture cross section to the fission cross section was determined for ^{235}U and ^{238}Pu at the center of a fast assembly (BFS-22). Calculated and experimental values of α are: 0.283 and 0.185 for ^{235}U, and 0.211 and 0.28 for ^{238}Pu. (K.S.W.)

32942 (KFK–1514) INVESTIGATION OF LOCATION DEPENDENCE OF THE NEUTRON SPECTRA IN PLANE AND TWO-DIMENSIONAL MODERATOR BOUNDARY LAYERS. Voigts, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Dec 1971. 114p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Karlsruhe Univ., Ger.

Theoretical and experimental investigations of the thermal neutron flux in the vicinity of a plane interface between pure and borated heavy water are described. The results show that even in regions with strong flux gradients the numerical integration of the neutron transport equation may be considered reliable, provided anisotropic scattering is taken into account at least in the P_1-approximation. However, the reentrant hole used for spectrum measurements by the time-of-flight technique strongly disturbed the flux. This effect was treated very accurately by an approximate calculation. As a further result a general relationship between the strongly position dependent neutron temperature and the neutron loss rate was found. In the loss rate the constant boron absorption has to be corrected for the gain caused by thermal neutrons diffusing into this region. While for practical reasons the problem of a two-dimensional interface cannot be treated exactly, near an edge of borated and unborated moderator regions sufficient agreement was found between the experimental results and a newly developed approximate method of calculation. (48 references) (auth)

32943 USE OF SIGNAL COHERENCE FOR ANOMALY DETECTION IN NUCLEAR REACTORS. Albrecht, Robert W. (Univ. of Washington, Seattle). Nucl. Technol.; 14: No. 3, 208-17(Jun 1972).

The theoretical background for the use of coherent detection in the determination of the existence of certain classes of anomalous behavior in nuclear reactors is developed. The analysis results in methods which can be useful for simulation of anomalous conditions in a power reactor by using normal power reactor noise combined with simulated anomalous conditions in a low power reactor. Scaling laws are derived which specify the transfer functions of electronic networks used to modify the signals from low power reactor experiments to make them compatible with the requirements for simulation. Preliminary experiments demonstrate procedures for the detection of simulated anomalies in low power reactors. (15 references) (auth)

GENERAL

32944 (IAEA-TA-553) ATOMIC ENERGY PLANNING. Report to the Government of Sierra Leone. Seligman, H. (International Atomic Energy Agency, Vienna (Austria)). 12 Jun 1970. 16p. INIS.

The Atomic Energy Planner gives an account of recommendations given by him to the Government of Sierra Leone on the potential role of nuclear energy in its economic and social development plans; a long-term program of the applications of atomic energy in the fields of teaching, medicine, application of radioelements, raw materials and energy; and the setting up of appropriate organs and installations for implementing the program. (INIS)

Civilian Defense

32945 (ORNL-4679) CIVIL DEFENSE RESEARCH PROJECT. Annual Progress Report, March 1970–March 1971. (Oak Ridge National Lab., Tenn.). Mar 1972. Contract W-7405-eng-26. 173p. Dep. NTIS.

Information is presented on urban research, civil defense systems analysis, rural and foreign civil defense, and weapons effects. (P.C.H.)

Law

32946 (AECL-3913) ANNUAL REPORT, 1970–1971. (Atomic Energy of Canada Ltd., Ottawa (Ontario)). Jun 1971. 52p. INIS.

The annual report, financial statement and auditor's report are presented for the fiscal year ending March 31, 1971. Two significant events during the year were the start-ups of the Gentilly reactor and the first unit of the Pickering generating station. Altogether, 14 Canadian-designed CANDU units with a total generating capacity of more than 6 million kilowatts are in operation or under construction. Development work to support the nuclear power projects includes studies on mechanical components, pressure tubes, heavy water technology, and fuels and materials. At Commercial Products, installation of a commercial prototype of the Slowpoke reactor and introduction of a neutron activation analysis service for trace elements were among the year's activities. Highlights of company research in nuclear physics, solid state, radiation chemistry, surfaces, analysis, radiation biology, and environmental research are described. In the operation of the research reactors, a significant event was the replacement of the reactor vessel in NRX. Other aspects of operations and administration, including computing services, electronics, personnel, public relations, and technical information are described. A program of collaboration with other nations, industry and universities was carried out during the year. Work on the Taiwan Research Reactor project continued. Construction of the 556-mile Nelson River transmission line was completed, and work continues on related facilities. (INIS)

32947 (AECL-3996) PHYSICS DIVISION PROGRESS REPORT, APRIL 1, 1971–JUNE 30, 1971. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 105p. (PR-P-90). Dep. NTIS (U. S. Sales Only). AECL $2.00.

Research in the areas of nuclear and solid state physics, solid state detectors, and mathematics and computers is briefly summarized. Publications, reports, and lectures during the period are listed. (C.E.S.)

32948 (ANCR-1039) FP9: FLOATING POINT ARITHMETIC SOFTWARE FOR DEC PDP-9 AND PDP-15 COMPUTERS. Myers, W. R. (Aerojet Nuclear Co., Idaho Falls, Idaho). Mar 1972. Contract AT(10-1)-1375. 48p. Dep. NTIS.

FP9 is a small fast interpretive arithmetic software package for Digital Equipment Corporation PDP-9 and PDP-15 computers, equipped with the extended arithmetic option (EAE), with up to 32,768 words of core memory. Versions are available for operation in either bank or page addressing modes. The routines have been modified during several years' use to provide an effective compromise among size, speed, and number of instructions. The arithmetic section requires less than 700_{10} words of memory to implement twenty-five floating point operations including float, fix, three-way compare, inverse divide, square, square root, and immediate add, multiply and divide, as well as the usual arithmetic operations. The full package, requiring less than 1300_{10} locations, includes relatively fast subroutines for the trigonometric and natural functions, and monitor- or user-oriented free-format input and variable-format output routines. (auth)

32949 (COO-3078-1) EARLY STEPS IN PROTEIN SYNTHESIS AND THEIR REGULATION: A BACKGROUND STUDY RELATED TO THE BIOLOGICAL EFFECTS OF RADIATION. Progress Report, September 1, 1970–August 31, 1971. (Massachusetts General Hospital, Boston. John Collins Warren Labs.). Contract AT(30-1)-2643. 16p. Dep. NTIS.

32950 (INIS-mf-198) ANNUAL REPORT OF THE DEPARTMENT OF ATOMIC ENERGY, GOVERNMENT OF INDIA, 1970–71. (Atomic Energy Commission, Bombay (India)). 1971. 174p. INIS.

The report highlights the significant work done by the various units of the Department of Atomic Energy such as, Bhabha Atomic Research Centre, Tata Institute of Fundamental Research, Physical Research Laboratory, Saha Institute of Nuclear Physics, Tata Memorial Centre, Indian Space Research Organization, Electronics Corporation of India Ltd., Atomic Minerals Division, Tarapur Atomic Power Station, Madras Atomic Power Project, Nuclear Fuel Complex, Uranium Corporation of India, Ltd., and Variable Energy Cyclotron Project during the year 1970–1971. It also presents a general survey of the future atomic energy program of India, which includes, among other things, commissioning by 1980 of 2700 MW of nuclear power, design and construction of advanced thermal reactors (of 500 MW unit size), design and construction of a prototype fast breeder reactor, augmentation of heavy water production, development of gas centrifuge technology for uranium enrichment, and the all around strengthening of support facilities. The plan for Space Research in the profile envisages creation of facilities for building scientific and communication satellites, and development by 1980 of a capability to launch 500 kg payloads into synchronous orbits. (INIS)

32951 (INS-504) PROGRESS REPORT NO. 17, JANUARY–JUNE 1971. (Institute of Nuclear Sciences, Lower Hutt (New Zealand)). 121p. Dep. NTIS (U. S. Sales Only).

Brief summaries of research projects on accelerators, instrumentation, experimental nuclear physics, NMR, cosmic radiation, radiation sources, radiation chemistry, radiation applications in industry, stable isotope geochemistry, radioactive dating and fallout, isotope applications, and electronic and mechanical equipment are given. Publications issued during the period are listed. (C.E.S.)

32952 (NP-19274) ANNUAL REPORT TO THE DIRECTOR-GENERAL FOR THE YEAR ENDED 30 JUNE 1971. (Commonwealth X-Ray and Radium Lab., Melbourne (Australia)). 1972. 33p. Dep. NTIS (U. S. Sales Only).

Activities for the year in the following fields are reviewed: National standards, radiation dosimetry, diagnostic radiography, care and maintenance of Australian ^{226}Ra and ^{222}Rn, radioactivity in the environment, radioisotopes and radiopharmaceuticals, radiation protection, whole-body monitoring and film-badge service. (M.R.M.)

32953 (ORNL-4761) MATHEMATICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1971. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 210p. Dep. NTIS.

Developments in mathematical research, computing applications, systems programming, computer services, and mathematical statistics are summarized. Seminars, professional activities, publications, reports, and papers and lectures are listed. (W.H.K.)

32954 (ORO-4065-5) AUTOMATION OF CHROMOSOME ANALYSIS AND APPLICATION TO HUMAN RADIATION CYTOGENETICS. Annual Progress Report, February 1971–March 1972. Bedford, Joel S. (Vanderbilt Univ., Nashville, Tenn. Dept. of Radiology). Contract AT(40-1)-4065. 9p. Dep. NTIS.

32955 (SC-M-720169) ANNOUNCEMENT OF THE AVAILABILITY OF A LAPLACE SIMULATION DIGITAL COMPUTER PROGRAM FFEARS. Boers, J. E. (Sandia Labs., Albuquerque, N. Mex.). Apr 1972. 3p. Dep. NTIS.

32956 (SC-M-720193) ANNOUNCEMENT OF THE AVAILABILITY OF SOR, SHELL OF REVOLUTION COMPUTER PROGRAMS. Von Riesemann, W. A. (Sandia Labs., Albuquerque, N. Mex.). Apr 1972. 6p. Dep. NTIS.

32957 (TT-71-50054/1) COMPUTER ELEMENTS AND SYSTEMS. Collection of Papers, Issues Nos. 32-34, 1969. Translation of Vychislitel'nye Sistemy, Izdatel'stvo Nauka Sibirskoe Otdelenie, Novosibirsk, 1969. 308p. (IPST-Cat.-600024; IPST-Cat.-600046). NTIS.

32958 (TT-71-50054/2) COMPUTER ELEMENTS AND SYSTEMS. Collection of Papers, Issues Nos. 35-37, 1969. Translation of Vychislitel'nye Sistemy, Izdatel'stvo Nauka Sibirskoe Otdelenie, Novosibirsk, 1969. 295p. (IPST-Cat.-600052; IPST-Cat.-600068; IPST-Cat.-600074). NTIS.

Miscellaneous

32959 (AEC-tr-7223/3-4) NUKLEONIKA. Translation of Nukleonika; 16: No. 3-4, 97-190(1971). 90p. (TT-70-55104/3-4). Dep. NTIS.

32960 (AECL-4064) NUCLEAR ENERGY AND RADIATIONS FROM RUTHERFORD AT McGILL TO THE PRESENT. Lewis, W. Bennett (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct 1971. 12p. (CONF-711048-1; DL-108). Dep. NTIS (U. S. Sales Only). AECL $0.50.
From Conference of the McGill Physical Society; Montreal, Canada (1 Oct 1971).

32961 (ANL-7886) CAMAC CRATE CONTROLLERS FOR THE SYSTEMS SEL-840 AND HONEYWELL DDP-24 COMPUTERS. Cohn, C. E.; Rudnick, S. J. (Argonne National Lab., Ill.). Feb 1972. Contract W-31-109-eng-38. 38p. Dep. NTIS.

32962 (ANL-Trans-914) INFLUENCE OF OXYGEN ON RECTIFICATION AT A METAL-SEMICONDUCTOR CONTACT. Cressely, Robert (Univ. of Strasbourg). Translated by J. W. Hammann for Argonne National Lab., Ill., from Advanced Study Diploma. 37p. Dep. NTIS.

32963 (BNWL-1596) ELECTRONIC INTERFERENCE REDUCTION IN ACOUSTIC EMISSION TESTING. Davis, T. J. (Battelle Pacific Northwest Labs., Richland, Wash.). Nov 1971. Contract AT(45-1)-1830. 18p. Dep. NTIS.

32964 (CEA-R-3597) ANALYTICAL REPRESENTATION OF TIME CORRELATION FUNCTIONS AND APPLICATION TO RELAXATION PROBLEMS. Dupuis, Marc (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct 1971. 128p. (In French). Dep. NTIS (U. S. Sales Only).
Thesis. Submitted to Faculte des Sciences, Univ. of Paris, France.

32965 (CEA-R-4164) STUDY AND DEVELOPMENT OF MAGNETIC RECORDING HEADS: A THIN FILM INTEGRATED MAGNETIC HEAD. Lazzari, Jean-Pierre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Feb 1972. 113p. (In French). Dep. NTIS (U. S. Sales Only).
Thesis. Submitted to Faculte des Sciences, Univ. of Grenoble, France.

32966 (CONF-720208-2) MODIFICATION OF THE SPLEEN COLONY-FORMING ASSAY TO DEMONSTRATE IMMUNOLOGIC CROSS-REACTIVITY OF ANTIGENS COMMON TO TUMOR AND FETAL CELLS. Salinas, F. A.; Smith, Jane A.; Hanna, M. G. Jr. (Oak Ridge National Lab., Tenn.). [1972]. 13p. Dep. NTIS.
From 2. conference on embryonic and fetal antigens in cancer; Oak Ridge, TN. (14 Feb 1972).

32967 (COO-1469-199) QUARTERLY TECHNICAL PROGRESS REPORT, OCTOBER-DECEMBER 1971. (Illinois Univ., Urbana. Dept. of Computer Science). Contracts AT(11-1)-1469; AT(11-1)-2118. 133p. (COO-2118-30; UIUCDCS-QPR-71-4). Dep. NTIS.

32968 (COO-1631-39) CONCERTED RESPONSE OF THE ENZYMES OF UREA BIOSYNTHESIS DURING THYROXINE-INDUCED METAMORPHOSIS OF RANA CATESBEIANA. Wixom, Robert L.; Reddy, M. Kumudavalli; Cohen, Philip P. (Wisconsin Univ., Madison. Dept. of Physiological Chemistry). [1971]. Contract AT(11-1)-1631. 39p. Dep. NTIS.

32969 (COO-2040-5) CHARACTERIZATION OF MAMMALIAN LYMPHOCYTES ON THE BASIS OF THEIR SURFACE RECEPTOR SITES FOR SPECIFIC MITOGENS. Comprehensive Progress Report, May 1, 1969-April 15, 1972. [Chicago Univ., Ill. Dept. of Microbiology]. Contract AT(11-1)-2040. 40p. Dep. NTIS.

32970 (COO-3013-6) KINETICS OF CELLULAR PROLIFERATION IN NORMAL AND MALIGNANT TISSUES. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiology). [nd]. Contract AT(30-1)-3970. 7p. (CONF-700456-1). Dep. NTIS.
From eighteenth annual meeting of the Association of University Radiologists; Lexington, Ky. (30 Apr 1970).

32971 (COO-3085-5) DEDIFFERENTIATED PATTERN OF ENZYMES IN LIVERS OF TUMOR-BEARING RATS. Herzfeld, Annemarie; Greengard, Olga (Harvard Medical School, Boston, Mass. New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.). [1971]. 26p. Dep. NTIS.

32972 (COO-3085-7) TITRATION OF TRYPTOPHAN OXYGENASE ANTIGEN BY IMMUNOINHIBITION. Li, Jeanne B.; Knox, W. Eugene (Harvard Medical School, Boston, Mass. New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.). [1972]. 20p. Dep. NTIS.

32973 (EDFB-IBP-72-5) DYNAMIC MODEL OF INSECT GRAZING IN A FOREST CANOPY. Goldstein, R. A.; Van Hook, R. I. Jr. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 46p. Dep. NTIS.

32974 (GAT-T-1858) ADDITIONAL FUNCTION FNEW FOR USE WITH FOCAL ON A PDP8L COMPUTER AND A NUCLEAR DATA 50/50 ANALYZER. Bowdle, John E. (Goodyear Atomic Corp., Piketon, Ohio). 21 Apr 1972. Contract AT(33-2)-1. 25p. Dep. NTIS.

32975 (INP-786) PREPARATION OF HIGH PURITY MAGNESIUM OXIDE. I. THE SEPARATION OF MICROQUANTITIES OF CALCIUM FROM MACROQUANTITIES OF MAGNESIUM. Debska-Horecka, Antonina; Pukas, Tadeusz; Stronski, Ignacy (Institute of Nuclear Physics, Krakow (Poland)). Dec 1971. 26p. Dep. NTIS (U. S. Sales Only).

32976 (INR-1338) GASEOUS ION-MOLECULE REACTIONS IN MULTIATOMIC SYSTEMS. Wincel, Henryk (Institute of Nuclear Research, Warsaw (Poland)). 1971. 161p. (In Polish). Dep. NTIS (U. S. Sales Only).

32977 (IPP-IV-10) INCREASE OF CHEMICAL LASER EFFICIENCY BY GASDYNAMICAL PUMPING. Ahlborn, B.; Kompa, K. L. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Jan 1971. 28p. Dep. NTIS (U. S. Sales Only).

32978 (IPP-6/104) METHOD OF SOLVING THE STABILITY PROBLEM FOR COMPLEX MATRICES. Meyer-Spasche, R. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Feb 1972. 55p. Dep. NTIS (U. S. Sales Only).

32979 (IS-T-518) LIGAND SUBSTITUTION OF PLATINUM(II) COMPLEXES: THE cis-DIBROMODIAMMINEPLATINUM(II)-BROMIDE-TETRABROMOPLATINATE(II) SYSTEM. Vandergrift III, George Fox (Ames Lab., Iowa). Apr 1972. Contract W-7405-eng-82. 102p. Dep. NTIS.
Thesis.

32980 (IS-Trans-87) HEAT CAPACITY OF AQUEOUS SOLUTIONS OF PERCHLORATES OF DIVALENT MANGANESE, COBALT, NICKEL, COPPER, AND ZINC. Latyscheva, V. A.; Kozhevnikov, O. A. Translated for Ames Lab., Iowa, from pp 146-52 of Termodinamicheskie i Termokhimicheskie Konstanty, 1970. 11p. Dep. NTIS.

32981 (JEN-226-SI/I-19) STUDY ON THE PISTON RING WEAR IN AUTOMATIVE ENGINE SEAT 1500 CA BY MEANS OF RADIOACTIVE TRACER TECHNIQUE. del Val Cob, M.; Chul Yoo, B.; Fuentes Figuera de Vargas, J. (Junta de Energia Nuclear, Madrid (Spain)). 1971. 62p. (In Spanish). Dep. NTIS (U. S. Sales Only).

32982 (KFKI-72-4) REFINEMENTS IN HIGH-VACUUM OIL VAPOR PUMPS. Vertesh-Tunyak, M. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Feb 1972. 74p. (In Russian). Dep. NTIS (U. S. Sales Only).

32983 (LA-4873) SCOPE DISPLAY INTERFACE TO A PDP-9 COMPUTER. Morris, R. A.; Dalton, L. J. (Los Alamos Scientific Lab., N. Mex.). Mar 1972. Contract W-7405-eng-36. 14p. Dep. NTIS.

32984 (LA-4906) TABLES OF PARA-HYDROGEN DATA IN THE INTERNATIONAL SYSTEM OF UNITS FROM 20 TO 3000°K AT PRESSURES TO 35 x 10^6 NM^{-2}. Farmer, Otis A.; Hafer, John F. (Los Alamos Scientific Lab., N. Mex.). Mar 1972. Contract W-7405-eng-36. 77p. Dep. NTIS.

32985 (LA-4921) VERDET CONSTANT MEASUREMENTS FOR FARADAY ROTATOR DEVELOPMENT. Liebenberg, Donald H. (Los Alamos Scientific Lab., N. Mex.). Apr 1972. Contract W-7405-eng-36. 5p. Dep. NTIS.

32986 (LA-4937) NANOSECOND FRAMING CAMERAS USING PROXIMITY FOCUSED IMAGE INTENSIFIERS. Sutphin, H. Dean; Lieber, Albert J. (Los Alamos Scientific Lab., N. Mex.). Apr 1972. Contract W-7405-eng-36. 5p. Dep. NTIS.

32987 (LBL-497) LABORATORY CHEMICAL KINETICS AS AN ATMOSPHERIC SCIENCE. Johnston, Harold (California Univ., Berkeley. Lawrence Berkeley Lab.). Feb 1972. Contract W-7405-eng-48. 71p. (CONF-720210-1). Dep. NTIS.

From Survey conference; Cambridge, MA. (15 Feb 1972).

32988 (LBL-800) DISLOCATION MODELING OF STRAIN-RATE PHENOMENA. Klahn, Dale Henry (California Univ., Berkeley. Lawrence Berkeley Lab.). Mar 1972. Contract W-7405-eng-48. 97p. Dep. NTIS.

Thesis.

32989 (MLM-1902) FOURIER TRANSFORM SPECTROSCOPY. Haws, L. D. (Mound Lab., Miamisburg, Ohio). 7 Apr 1972. Contract AT-33-1-GEN-53. 16p. Dep. NTIS.

32990 (NP-19286) MICROWAVE MEASUREMENT OF PERMITTIVITY AND LOSS FACTOR OF SOLIDS AND LIQUIDS BY A CAVITY PERTURBATION METHOD. Note No. 352. Bonincontro, A.; Cametti, C. (Rome Univ. (Italy). Istituto di Fisica). 18 Dec 1971. 18p. Dep. NTIS (U. S. Sales Only).

32991 (NP-19293) EXPERIMENTAL AND THEORETICAL OUTLINES OF A NEW INTERFEROMETRIC TECHNIQUE TO REJECT THE CENTRAL LINE IN RAMAN SPECTROSCOPY. Note No. 359. Mazzacurati, V. (Rome Univ. (Italy). Istituto di Fisica). 11 Feb 1972. 24p. Dep. NTIS (U. S. Sales Only).

32992 (NP-19294) RAMAN SPECTROSCOPY OF TURBID SUSPENSIONS AND POWDERS. Note No. 346. Mazzacurati, V. (Rome Univ. (Italy). Istituto di Fisica). 23 Nov 1971. 49p. (In Italian). Dep. NTIS (U. S. Sales Only).

32993 (NYO-3970-38) CELL POPULATION KINETICS IN LYMPHOCYTES IN MOUSE AND RAT THYMUS. Fabrikant, Jacob I.; Foster, Bessie R. (Johns Hopkins Univ., Baltimore, Md.). [1971]. Contract AT(30-1)-3970. 14p. Dep. NTIS.

32994 (NYO-3970-42) KINETICS OF CELLULAR PROLIFERATION IN NORMAL AND MALIGNANT TISSUES. XII. IN VITRO LABEL. Fabrikant, Jacob I. (Connecticut Univ., Farmington. Dept. of Radiology). [nd]. Contract AT(30-1)-4244. 10p. (CONF-700228-1). Dep. NTIS.

From Symposium on the growth kinetics of solid tumors; Williamsburg, VA. (8 Feb 1970).

32995 (NYO-3970-43) KINETICS OF CELLULAR PROLIFERATION IN NORMAL AND MALIGNANT TISSUES. Fabrikant, Jacob I. (Connecticut Univ., Hartford. Dept. of Radiology). [nd]. Contract AT(30-1)-4244. 18p. (CONF-700570-1). Dep. NTIS.

From Conference on radiotherapy; New York, NY. (6 May 1970).

32996 (ORNL-EIS-72-20) POLYCHLOROBIPHENYLS(PCBs) AND RELATED CHLOROPHENYLS: EFFECTS ON HEALTH AND ENVIRONMENT. I. BIBLIOGRAPHY: 1881-1971. Quinby, Griffith E. (Oak Ridge National Lab., Tenn.). Apr 1972. 142p. (TIRC-1). Dep. NTIS.

32997 (ORNL-IIC-35) NUCLEAR EDUCATION EXPERIMENTS IN BIOLOGY, CHEMISTRY, AND PHYSICS: A CROSS-REFERENCED INDEX. Shor, Roberta; Lafferty, R. H.; Baker, P. S. (comps.) (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 137p. Dep. NTIS.

Approximately 700 titles from 31 collections of college level experiments of wide variety are listed and cross referenced. (auth)

32998 (ORNL-NSF-EP-10) REGIONAL MODELING ABSTRACTS. VOLUME II. Meyers, Charles R. Jr. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 310p. (ORNL-EIS-71-7). Dep. NTIS.

32999 (ORNL-NSF-EP-19) LABOR FORCE PARTICIPATION IN EAST TENNESSEE. Olsen, Richard J. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 48p. Dep. NTIS.

33000 (ORNL-TM-3741) ECONOMIC ALTERNATIVES AND POLICY IMPLICATIONS OF A STRATEGIC COMMODITY RESERVE FOR NATIONAL SECURITY CONSIDERATIONS. Garland, Clark David (Oak Ridge National Lab., Tenn.). Mar 1972. Contract W-7405-eng-26. 172p. Dep. NTIS.

Thesis. Submitted to Tennessee Univ., Knoxville.

33001 (ORNL-TM-3752) INTERACTION OF PHOTONS AT ROUGH DIELECTRIC SURFACES. Elson, J. M.; Ritchie, R. H. (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 100p. Dep. NTIS.

Thesis. Submitted by J. M. Elson to Univ. of Kentucky, Lexington.

33002 (ORNL-TM-3790) CATCH: COMPUTER ASSISTED TOPOGRAPHY, CARTOGRAPHY, AND HYPSOGRAPHY. PART II. ORGRAT: A GENERAL SUBROUTINE FOR DRAWING GRATICULES. Stephenson, R. L. (Oak Ridge National Lab., Tenn.). 18 Apr 1972. Contract W-7405-eng-26. 19p. Dep. NTIS.

33003 (ORNL-tr-2590) EFFECT OF ZINC METALLURGY ON SOIL. Greszta, Jan; Godzik, Stefan. Translated for Oak Ridge National Lab., Tenn., from Rocz. Glebozn.; 20: No. 1, 195-215(1969). 17p. Dep. NTIS.

33004 (RFP-Trans-95) PRELIMINARY EXPERIMENTS ON STRESS WAVE EMISSION DETECTION. Niwa, Noboru; Sagehashi, Ichitaro; Hatano, Hajime (Tokyo Univ. (Japan)). Translated for Dow Chemical Co., Rocky Flats Div., from Japanese report AE5-16. 9p. Dep. NTIS.

33005 (RLO-2225-T-21-6) SYNOPTIC MEASUREMENTS OF CURRENTS AND SEDIMENT TRANSPORT ON THE CONTINENTAL SHELF. Annual Progress Report. Sternberg, Richard W. (Washington Univ., Seattle). 24 Apr 1972. Contract AT(45-1)-2225. 7p. Dep. NTIS.

33006 (SC-CR-715135) SYNTHESIS OF DIFLUORAMINOHEXANITROBIPHENYL COMPOUNDS: 3-DIFLUORAMINO-2,2',4,4',6,6'-HEXANITROBIPHENYL AND 3,3'-BIS(DIFLUORAMINO)-2,2',4,4',6,6'-HEXANITROBIPHENYL. Lerom, Michael W.; Peters, Howard M.; Ross, Donald L.; Hill, Marion E. (Stanford Research Inst., Menlo Park, Calif.); Dick, John R. (Sandia Labs., Albuquerque, N. Mex.). [1971]. 11p. Dep. NTIS.

33007 (SC-CR-715136) SYNTHESIS OF DIFLUORAMINOPOLYNITROTERPHENYL COMPOUNDS: 3,3''-BIS(DIFLUORAMINO)-2,2'', 4,4',4'',6,6',6''-OCTANITRO-m-TERPHENYL AND 3,3''-BIS-(DIFLUORAMINO)-2,2',2'',4,4',4'',6,6',6''-NONANITRO-m-TERPHENYL. Peters, Howard M.; Lerom, Michael W.; Ross, Donald L.; Hill, Marion E. (Stanford Research Inst., Menlo Park, Calif.). [1971]. 19p. Dep. NTIS.

33008 (SC-DC-714410) CHARACTERIZATION OF THIN FILMS BY X-RAY EMISSION SPECTROSCOPY. Lawson, K. E. (Sandia Labs., Albuquerque, N. Mex.). [1970]. 1p. (CONF-720315-1). Dep. NTIS.

From Pittsburgh conference on analytical chemistry and applied spectroscopy; Cleveland, OH. (6 Mar 1972).

33009 (SC-DC-721230) HOLOGRAPHY IN A MODERN LABORATORY. Murphy, Carl G.; Landry, Murphy J. (Sandia Labs., Albuquerque, N. Mex.). Apr 1972. 26p. (CONF-720422-1). Dep. NTIS.

From sixth Instrument Society of America symposium; Albuquerque, NM. (24 Apr 1972).

33010 (SC-DC-721256) DEVELOPMENT OF A FIBER OPTICS SYSTEM FOR HYDRODYNAMIC MEASUREMENTS. Goodman, Albert (Sandia Labs., Albuquerque, N. Mex.). [1972]. 10p. (CONF-720422-2). Dep. NTIS.

From sixth Instrument Society of America symposium; Albuquerque, NM. (24 Apr 1972).

33011 (SC-DC-722277) ORTHOGONAL MODES FOR THE SOLUTION TO STATIC NONLINEAR PROBLEMS. Kavanagh, Kenneth T. (Sandia Labs., Albuquerque, N. Mex.). [1972]. 20p. (CONF-720601-1). Dep. NTIS.

From Finite element method in civil engineering conference; Montreal, Canada (1 Jun 1972).

33012 (SC-DR-720250) EXACT AND APPROXIMATE SOLUTIONS FOR RADIATION BETWEEN INFINITE PARALLEL PLATES WITH DIRECTIONAL PROPERTIES. Moreno, J. B. (Sandia Labs., Albuquerque, N. Mex.). Apr 1972. 11p. Dep. NTIS.

33013 (SC-RR-720242) PROBABILITY DISTRIBUTIONS INDUCED ON p-DIMENSIONAL SUBSPACES BY A UNIFORM DISTRIBUTION ON A HYPERSPHERE. Bechtel, F. K. (Sandia Labs., Albuquerque, N. Mex.). Apr 1972. 15p. Dep. NTIS.

33014 (SC-T-722495) PROCESS OF FORMATION AND PROPERTIES OF CARBON BLACK IN PLASMA-BEAM PYROLYSIS OF BENZENE. Vinokurov, L. Kh.; Kokurin, A. D.; Levanovskii, V. I. Translated for Sandia Labs., Albuquerque, N. Mex., from Zh. Prikl. Khim.; 44: No. 11, 2528-32(1971). 12p. Dep. NTIS.

33015 (SC-T-722496) THEORY OF CARBON-BLACK FORMATION. Samkhan, I. I.; Tsvetkov, Yu. V.; Petrunichev, V. A.; Glushko, I. K. Translated for Sandia Labs., Albuquerque, N. Mex., from Kolloid. Zh.; 33: No. 6, 885-91(1971). 14p. Dep. NTIS.

33016 (SCL-DR-710351) CHARACTERIZATION OF FLOW GEOMETRIES IN FLOW CONTROL DEVICES. German, R. M. (Sandia Labs., Livermore, Calif.). Mar 1972. Contract AT(29-1)-789. 35p. Dep. NTIS.

33017 (SCL-RR-720007) FORMULATION OF THE EQUATIONS OF MOTION FOR FLIGHT VEHICLES WITH SEMI-PASSIVE ROLL-CONTROL SYSTEMS. Kryvoruka, John K. (Sandia Labs., Livermore, Calif.). Apr 1972. Contract AT(29-1)-789. 50p. Dep. NTIS.

33018 (SCL-RR-720227) INFLUENCE OF MICROSTRUCTURE ON LOW-TEMPERATURE CREEP OF Ti-5 Al-2.5 Sn. Thompson, Anthony W.; Odegard, Ben C. (Sandia Labs., Livermore, Calif.). Mar 1972. Contract AT(29-1)-789. 42p. Dep. NTIS.

33019 (SGAE-G-15/1971) NUCLEAR RESEARCH; ECONOMY; SOCIETY. Gruemm, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna). [nd]. 21p. (In German). (CONF-711216-1). Dep. NTIS (U. S. Sales Only).

From German Atom Forums conference; Bonn, Germany (Dec 1971).

33020 (TID-3766) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Issued or in Progress During the Period January-March 1972. (Technical Information Center (AEC), Oak Ridge, Tenn.). 10p. TIC Free.

33021 (TID-4028(Suppl.1)) USAEC TRANSLATION LIST INDEX, 1970-1971. (Technical Information Center (AEC), Oak Ridge, Tenn.). Apr 1972. 124p. Dep. NTIS.

33022 (TID-25983) FORMATION AND ACTIVITIES OF KYOTO UNIVERSITY ATOMIC BOMB CASUALTY GENERAL INVESTIGATION TEAM. Kikuchi, Takehiko (Atomic Bomb Casualty Commission, Hiroshima (Japan). Atomic Bomb Casualty Commission, Nagasaki (Japan)). Feb 1970. 86p. Dep. NTIS.

33023 (UCID-30021(Rev.1)) PRELIMINARY USER'S MANUAL FOR THE STAR SYSTEM SOFTWARE. Requa, Joseph E.; Coverston, Harriet G.; Du Bois, Pierre; Emery, Donald R.; Kent, Douglas A.; Lund, Paul E.; Richards, Marilyn D.; Storch, David F.; Vranesh, George E. (California Univ., Livermore. Lawrence Livermore Lab.). 9 Mar 1972. Contract W-7405-eng-48. 204p. Dep. NTIS.

33024 (UCID-30025) SUBROUTINES FOR CONVERTING DATA BLOCKS BETWEEN THE CDC-STAR 100 AND THE CDC 6600 AND 7600. Malone, Robert L. (California Univ., Livermore. Lawrence Livermore Lab.). 8 Oct 1971. Contract W-7405-eng-48. 42p. Dep. NTIS.

33025 (UCRL-50335(Rev.1)) MERCURY POOL CELL FOR CONTROLLED-POTENTIAL COULOMETRY. Harrar, J. E. (California Univ., Livermore. Lawrence Livermore Lab.). 15 Mar 1972. Contract W-7405-eng-48. 8p. Dep. NTIS.

33026 (UCRL-51186) LINEAR MULTISTEP METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS: METHOD FORMULATIONS, STABILITY, AND THE METHODS OF NORDSIECK AND GEAR. Hindmarsh, A. C. (California Univ., Livermore. Lawrence Livermore Lab.). 20 Mar 1972. Contract W-7405-eng-48. 26p. Dep. NTIS.

33027 (UCRL-73638) ISENTROPIC COMPRESSION OF FUSED QUARTZ AND LIQUID HYDROGEN TO SEVERAL MEGABARS. Hawke, R. S.; Duerre, D. E.; Huebel, J. G.; Keeler, R. N.; Klapper, H. (California Univ., Livermore. Lawrence Livermore Lab.). 10 Apr 1972. 15p. (CONF-720318-2). Dep. NTIS.

From High pressure physics and planetary interiors conference; Houston, TX. (1 Mar 1972).

33028 (UCRL-Trans-10601) GAS DEPOSITS OF THE USSR; MANUAL. Vasil'ev, V. G. (ed.). Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from pp 92-3; 274-6; 626-8 of Gazove Mestorozhdeniya SSSR; Spravochnik, 2nd Edition, Nedra, Moscow, 1968. 14p. Dep. NTIS.

33029 (UCRL-Trans-10608) PROPAGATION OF SHOCK WAVES WITH SLIP. Vatolin, Yu. N. Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from Chislennye Metody Mekh. Sploshnoi Sredy; 2: No. 5, 111-14(1971). 8p. Dep. NTIS.

33030 (WAPD-TM-1014) EFFECT OF EROSION AND DEPOSITION ON SAMPLING OF ENTRAINED PARTICLES. Beal, S. K. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr 1972. Contract AT-11-1-GEN-14. 59p. Dep. NTIS.

33031 TABLITSY PO SVETORASSEYANIYU. TOM IV. RASSEYANIE POLIDISPERSNYMI SISTEMAMI. (Light-Scattering Tables. Volume 4. Scattering of Polydispersed Systems). Zel'manovich, I. L.; Shifrin, K. S. Leningrad; Gidrometeorologicheskoe Izdatel'stvo (1971). 168p.

The tables contain calculated data on optical characteristics of polydispersing systems. The tables are divided into two sections. Listed in Section 1 are three-digit values of polydispersion coefficients of extinction, scattering and light pressure in clouds, mist and water aerosol within the range of wavelengths from 0.6 to 40 μ. All in all, 124 wavelengths were considered, of which number 13 are generated by lasers. Section 2 contains three-digit values of polydispersion indicatrices and polarization indices of scattered radiation calculated for 12 wavelengths within the spectral range from 0.4 to 12.3 μ. Here, 35 gamma-distribution models and 9 Junge (or Junge-type) models were employed. The calculation was made for 37 values of scattering angles. The tables may find application in physical and atmospheric optics, actinometry, thermophysics, lighting engineering, and technology. (auth)

Appendix I

JOURNAL LIST

This list of journals supplements the listing which appeared as Appendix II in Volume 26, Number 1. The journals are arranged alphabetically by abbreviation. An additional supplement will be included in number 19 of this volume.

The title abbreviations are based on the National Clearinghouse for Periodical Title Word Abbreviations, *Word Abbreviation List* published by the Standards Committee Z-39 of the American National Standards Institute.

TID-4579 (6th Ed.) *Serial Titles Cited in Nuclear Science Abstracts* lists the titles and abbreviations of the journals regularly scanned for *NSA* as well as those from which an occasional item is taken. This publication is available from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia, 22151, for $6.00 for full size or reproduction copy and $0.95 for microfiche copy.

A

Acta Radiobot. Genet.
Acta Radiobotanica et Genetica (Japan)

Acta Univ. Agr. (Brno), Ser. C
Acta Univ. Agr. (Brno), Series C (Facultas Silviculturae) (Czechoslovakia)

Acta Univ. Upsal., Abstr. Uppsala Diss. Fac. Sci.
Acta Universitatis Upsaliensis, Abstracts of Uppsala Dissertations from the Faculty of Science (Sweden)
Supersedes Acta Univ. Upsal., Abstr. Uppsala Diss. Sci.

Advan. Instrum.
Advances in Instrumentation (U.S.)

Aerotec.-Missili Spazio
Aerotecnica-Missili e Spazio (Italy)
Formed by merger of Aerotecnica and Missili e Spazio

Ag Chem Commer. Fert.
Ag Chem and Commercial Fertilizer (U.S.)
Supersedes Agr. Chem.

Alimenta (Zurich)
Alimenta (Zurich) (Switzerland)

Allianz Ber. Betriebstech. Schadenverhuetung
Allianz Berichte fuer Betriebstechnik und Schadenverhuetung (West Germany)

Amer. Chem. Soc., Div. Water, Air Waste Chem., Gen. Pap.
American Chemical Society, Division of Water, Air and Waste Chemistry, General Papers (U.S.)

Amer. Fam. Physician
American Family Physician (U.S.)
Supersedes American Family Physician - GP

An. Asoc. Quim. Argent.
Anales de la Asociacion Quimica Argentina (Argentina)

Ann. Acad. Sci. Fenn., Ser. A III
Annales Academiae Scientiarum Fennicae, Series A III. Geologica-Geographica (Finland)

Ann. Acad. Sci. Fenn., Ser. A V
Annales Academiae Scientiarum Fennicae, Series A V. Medica (Finland)

Ann. Sci. Forest.
Annales des Sciences Forestieres (France)

Ann. Univ. Sarav., Math.-Naturwiss. Fak.
Annales Universitatis Saraviensis, (Reihe), Mathematisch-Naturwissenschaftliche Fakultaet (West Germany)

Annu. Rep. Progr. Chem., Sect. A
Annual Reports on the Progress of Chemistry, Section A. General, Physical and Inorganic Chemistry (England)

Annu. Rev. Mater. Sci.
Annual Review of Materials Science (U.S.)

An. Univ. Bucuresti, Chim.
Analele Universitatii Bucuresti, Chimie (Romania)

Appl. Elec. Phenomena (Engl. Transl.)
Applied Electrical Phenomena (English Translation of Elektronnaya Obrabotka Materialov) (U.S.)

Appl. Solar Energy (USSR) (Engl. Transl.)
Applied Solar Energy (USSR) (English Translation of Geliotekhnika) (U.S.)

Araneta J. Agr.
Araneta Journal of Agriculture (Philippines)

Arch. Dermatol. Forsch.
Archiv fuer Dermatologische Forschung (West Germany)
Supersedes Arch. Klin. Exp. Dermatol.

Arch. Fund. Roux-Ocefa
Archivos de la Fundacion Roux-Ocefa (Argentina)

Arch. Julius Klaus-Stift. Vererbungsforsch., Sozialanthropol. Rassenhyg.
Archiv der Julius Klaus-Stiftung fuer Vererbungsforschung, Sozialanthropologie und Rassenhygiene (Switzerland)

Arch. Sci. Biol. (Bologna)
Archivio di Scienze Biologiche (Bologna) (Italy)

Arctic
Arctic (U.S. - Canada)

Ark. Mat., Astron. Fys.
Arkiv for Matematik, Astronomi och Fysik (Sweden)

Astronautyka
Astronautyka (Poland)

At. Jap.
Atoms in Japan (Japan)

Aufbereit.-Tech.
Aufbereitungs-Technik (West Germany)

Aufschluss
Aufschluss (West Germany)

Awamia
Awamia, Al (Morocco)

B

Ber. Getreidechem.-Tag., Detmold
Bericht ueber die Getreidechemiker-Tagung, Detmold
(West Germany)

Beton, Herstellung, Verwend.
Beton, Herstellung, Verwendung (West Germany)

Biol. Gastro-Enterol.
Biologie et Gastro-Enterologie (Supplement to Archives
Francaise des Maladies de l'Appareil Digestif) (France)

Biol. Neonate
Biology of the Neonate (Switzerland)
Supersedes Biol. Neonatorum

Bitki Koruma Bul.
Bitki Koruma Bulteni (Plant Protection Bulletin) (Turkey)

Bitumen, Teere, Asphalte, Peche
Bitumen, Teere, Asphalte, Peche und Verwandte Stoffe
(West Germany)

Boll. Mal. Orecchio, Gola Naso
Bollettino delle Malattie dell'Orecchio, della
Gola e del Naso (Italy)

Boll. Soc. Geol. Ital.
Bollettino della Societa Geologica Italiana (Italy)

Boll. Unione Mat. Ital.
Bollettino dell'Unione Matematica Italiana (Italy)

Boll. Unione Mat. Ital., Ser. IV
Bollettino delle Unione Matematica Italiana, Series IV
(Italy)

Bot. Rev.
Botanical Review, THe (U.S.)

Brit. Chem. Eng. Process Technol.
British Chemical Engineering and Process Technology
(England)
Supersedes British Chemical Engineering

Brit. Engine Tech. Rep.
British Engine Technical Reports (England)

Bull. Ass. Anciens Eleves Inst. Ind. Ferment. Bruxelles
Bulletin de l'Association des Anciens Eleves de
l'Institut des Industries de Fermentation de Burxelles
(Belgium)

Bull. Bot. Soc. Bengal
Bulletin of the Botanical Society of Bengal (India)

Bull. Doc., Cent. Inform. Chrome Dur
Bulletin de Documentation, Centre d'Information du
Chrome Dur (France)

Bull. Grain Technol.
Bulletin of Grain Technology (India)

Bull. Sci., Cons. Acad. Sci. Arts RSF Yougoslavie, Sect. A
Bulletin Scientifique, Conseil des Academies des Sciences
et des Arts de la RSF de Yougoslavie, Section A. Sciences
Naturelles, Techniques et Medicales (Yugoslavia)

Byull. Inst. Astrofiz., Akad. Nauk Tadzh. SSR
Byulleten Instituta Astrofiziki, Akademiya Nauk
Tadzhikskoi SSR (Tadzhik S.S.R.)

Byull. Nauch.-Tekh. Inform. Agron. Fiz.
Byulleten Nauchno-Tekhnicheskoi Informatsii po
Agronomicheskoi Fizike (U.S.S.R.)

Byull. Tsentra Yadern. Dannym
Byulleten Tsentra po Yadernym Dannym (U.S.S.R.)

C

Can. Geogr.
Canadian Geographer (Canada)

Can. J. Pharm. Sci.
Canadian Journal of Pharmaceutical Sciences (Canada)

Cardiology
Cardiology (Switzerland)
Supersedes Cardiologia

Cell. Immunol.
Cellular Immunology (U.S.)

Chagyo Gijutsu Kenkyu
Chagyo Gijutsu Kenkyu (Study of Tea) (Japan)

Chem. Chron., Epistem. Ekdosis
Chemika Chronika, Epistemonike Ekdosis (Greece)

Chem. Stosow., Ser. B
Chemia Stosowana, Seria B. Kwartalnik Poswiecony
Zagadnieniom Inzynierii i Aparatury Chemicznej
(Poland)

Chem.-Ztg., Chem. App.
Chemiker-Zeitung, Chemische Apparatur (West Germany)
Supersedes Chemiker-Zeitung

Chislennye Metody Mekh. Sploshnoi Sredy
Chislennye Metody Mekhaniki Sploshnoi Sredy (U.S.S.R.)

Clin. Otorinolaringoiat.
Clinica Otorinolaringoiatrica (Italy)

Collect. Treatises Fac. Hum., Univ. Fukuoka
Collection of Treatises Published by Faculty of Humanity,
University of Fukuoka (Japan)

Commentat. Biol.
Commentationes Biologicae, Societas Scientiarum Fennica
(Finland)

Comments Plasma Phys. Controlled Fusion
Comments on Plasma Physics and Controlled Fusion (England)

Computing
Computing (Austria)

Confructa
Confructa (West Germany)

Contam. Contr.
Contamination Control (U.S.)

Cryog. Eng. (Tokyo)
Cryogenic Engineering (Tokyo) (Japan)

Curr. Top. Radiat. Res. Quart.
Current Topics in Radiation Research Quarterly (Netherlands)
Supersedes Curr. Top. Radiat. Res.

Cutting Tool Eng.
Cutting Tool Engineering (U.S.)

D

Dainichi-Nippon Densen Jiho
Dainichi Nippon Densen Jiho (Dainichi-Nippon Cables
Review) (Japan)

Delt. Hellen. Mikrobiol. Hyg. Hetair.
Deltion Hellenikes Mikrobiologikes kai Hygieinologikes
Hetaireias (Greece)

Demag Nachr.
Demag Nachrichten (West Germany)

Denki Keisan
Denki Keisan (Electrical Calculaton) (Japan)

Denshi Gijutsu Sogo Kenkyusho Chosa Hokoku
Denshi Gijutsu Sogo Kenkyusho Chosa Hokoku (Japan)

Dermatol. Monatsschr.
Dermatologische Monatsschrift (East Germany)

Doboku Gijutsu Shiryo
Doboku Gijutsu Shiryo (Public Works Review) (Japan)

Draht
Draht (West Germany)

Draht-Welt
Draht-Welt (West Germany)

Drug Ther. Bull.
Drug and Therapeutics Bulletin (England)

E

Earth Sci. Bull.
Earth Science Bulletin (U.S.)

Ecology (USSR) (Engl. Transl.)
Ecology (USSR) (English Translation of Ekologiya) (U.S.)

Econ. Int. Fonti Energ.
Economia Internazionale delle Fonti di Energia (Italy)

Econ. Trentina
Economia Trentina (Italy)

Ekologiya
Ekologiya (U.S.S.R.)

Elec. News Eng.
Electrical News and Engineering (Canada)

Elektro-Anz.
Elektro-Anzeiger (West Germany)

Elektronik (Munich)
Elektronik (Munich) (West Germany)

Elektron.-Ztg.
Elektronik-Zeitung (West Germany)

Elektrotechniek
Elektrotechniek (Netherlands)

Elelmiszervizsgalati Kozlem.
Elelmiszervizsgalati Kozlemenyek (Hungary)

Energ. Elek.
Energetika i Elektrifikatsiya (Ukrainian S.S.R.)

Energiewirt. Tagesfragen
Energiewirtschaftliche Tagesfragen (West Germany)

Eng. Cybern. (USSR) (Engl. Transl.)
Engineering Cybernetics (USSR) (English Translation of Izvestiya Akademii Nauk SSSR, Tekhnicheskaya Kibernetika) (U.S.)

Environ. Aff.
Environmental Affairs (U.S.)

Environ. Contr. Saf. Manage.
Environmental Control and Safety Management (U.S.)

Enzyme
Enzyme (Switzerland)
Supersedes Enzymol. Biol. Clin.

EOS, Trans., Amer. Geophys. Union
EOS, Transactions, American Geophysical Union (U.S.)
Supersedes Trans. Amer. Geophys. Union

Eur. J. Clin. Pharm.
European Journal of Clinical Pharmacology Continues Pharmacol. Clin.

Europlast. Mon.
Europlastics Monthly (England)
Supersedes British Plastics

Eur. S. Observ., Bull.
European Southern Observatory, Bulletin (West Germany)

F

Farmacia (Bucharest)
Farmacia (Bucharest) (Romania)

Farm J. (Calcutta)
Farm Journal (Calcutta) (India)

Fertigung
Fertigung (Switzerland)

Festkoerperprobleme
Festkoerperprobleme (West Germany)

Fiz. Elem. Chastits At. Yadra
Fizika Elementarnykh Chastits i Atomnogo Yadra (U.S.S.R.)

Fiz. Szk.
Fizyka w Szkole (Poland)

Folia Forest. (Helsinki)
Folia Forestalia (Helsinki) (Finland)

G

Galvano
Galvano (France)

Gartenbauwissenschaft
Gartenbauwissenschaft (West Germany)

Geliotekhnika
Geliotekhnika (Uzbek S.S.R.)
Issued in English translation as Applied Solar Energy (USSR)

Geokhim. Sb.
Geokhimicheskii Sbornik (U.S.S.R.)

Gesuido Kyokai-Shi
Gesuido Kyokai-Shi (Journal of Japan Sewage Works Association) (Japan)

Glastech. Ber.
Glastechnische Berichte (West Germany)

God. Sofii. Univ., Biol. Fak.
Godishnik na Sofiiskiya Universitet, Biologicheski Fakultet (Bulgaria)

God. Sofii. Univ., Fiz. Fak.
Godishnik na Sofiiskiya Universitet, Fizicheski Fakultet (Bulgaria)

God. Zb. Med. Fak. Skopje
Godisen Zbornik na Medicinskiot Fakultet vo Skopje (Yugoslavia)

Gravitatsiya Teor. Otnositel'nosti
Gravitatsiya i Teoriya Otnositel'nosti (U.S.S.R.)

H

Haematol. Bluttransfus.
Haematologie und Bluttransfusion (Suppl. to Blut)
(West Germany)

Han'guk Sikp'um Kwahakhoe Chi
Han'guk Sikp'um Kwahakhoe Chi (Journal of the Korean
Society of Food Science and Technology) (South Korea)

Heft Unfallheilk.
Heft zur Unfallheilkunde; Beiheft zur Monatsschrift
fuer Unfallheilkunde, Versicherungs-, Versorgungs-
und Verkehrsmedizin (West Germany)

Hiroshima Daigaku Genbaku Hoshano Igaku Kenkyusho Nenpo
Hiroshima Daigaku Genbaku Hoshano Igaku Kenkyusho Nenpo
(Proceedings of the Research Institute for Nuclear
Medicine and Biology, Hiroshima University) (Japan)

Hiroshima Nogyo Tanki Daigaku Kenkyu Hokoku
Hiroshima Nogyo Tanki Daigaku Kenkyu Hokoku (Bulletin of
the Hiroshima Agricultural College) (Japan)

Hokkaido Daigaku Kogakubu Kenkyu Hokoku
Hokkaido Daigaku Kogakubu Kenkyu Hokoku (Bulletin of the
Faculty of Engineering, Hokkaido University) (Japan)

HortScience
HortScience (U.S.)

Hoshasen Butsuri Kenkyu
Hoshasen Butsuri Kenkyu (Japan)

Hum. Pathol.
Human Pathology (U.S.)

I

IEE (Inst. Elec. Eng.) Rev.
IEE (Institution of Electrical Engineers) Reviews
(A Special Issue of the Proc. Inst. Elec. Eng.)
(England)

Ind.-Elek. Elektron.
Industrie-Elektrik und Elektronik (West Germany)

Indiana Univ. Math. J.
Indiana University Mathematics Journal (U.S.)
Supersedes J. Math. Mech.

Indian Eng.
Indian Engineer (India)

Indian Geotech. J.
Indian Geotechnical Journal (India)

Indian J. Anim. Sci.
Indian Journal of Animal Sciences (India)

Indian J. Biochem. Biophys.
Indian Journal of Biochemistry and Biophysics (India)
Continues Indian J. Biochem.

Indian J. Vet. Sci. Anim. Husb.
Indian Journal of Veterinary Science and Animal
Husbandry (India)
Continued as Indian J. Anim. Sci.

Indian Mining Eng. J.
Indian Mining and Engineering Journal (India)

Ingegneria
Ingegneria (Italy)

Instrum. Power Ind.
Instrumentation in the Power Industry (U.S.)

Int. Comp. Law Quart.
International and Comparative Law Quarterly, The
(England)

Int. J. Environ. Anal. Chem.
International Journal of Environmental Analytical Chemistry
(England)

Int. J. Mech. Sci.
International Journal of Mechanical Sciences (England)

Int. Ver. Theor. Angew. Limnol., Mitt.
International Vereinigung fuer Theoretische und Angewandte
Limnologie, Mitteilungen (West Germany)

Iwate Igaku Zasshi
Iwate Igaku Zasshi (Journal o the Iwate Medical Association)
(Japan)

Izotoptechnika
Izotoptechnika (Hungary)
Supersedes Atomtech. Tajek.

Izv. Akad. Nauk Tadzh. SSR, Otd. Fiz.-Mat. Geol.-Khim. Nauk
Izvestiya Akademii Nauk Tadzhikskoi SSR, Otdelenie
Fiziko-Matematicheskikh i Geologo-Khimicheskikh Nauk
(Tadzhik S.S.R.)

Izv. Estestvennonauch. Inst. Perm. Gos. Univ.
Izvestiya Estestvennonauchnogo Instituta pri Permskom
Gosudarstvennom Universitete (U.S.S.R.)

Izv. Leningrad. Elektrotekh. Inst.
Izvestiya Leningradskogo Elektrotekhnicheskogo Instituta
(U.S.S.R.)

Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Biol. Nauk
Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR,
Seriya Biologicheskikh Nauk (U.S.S.R.)
Supersedes Izv. Sib. Otd. Akad. Nauk SSSR, Ser.
Biol.-Med. Nauk

Izv. Vyssh. Ucheb. Zaved., Neft Gaz
Izvestiya Vysshikh Uchebnykh Zavedenii, Neft i Gaz
(Azerbaidzhan S.S.R.)

J

J. Allergy Clin. Immunol.
Journal of Allergy and Clinical Immunology (U.S.)
Supersedes J. Allergy

J. Chem. Soc., Chem. Commun.
Journal of the Chemical Society (London),
Chemical Communications (England)
Supersedes J. Chem. Soc., D

J. Chem. Soc., Dalton Trans.
Journal of the Chemical Society (London), Dalton
Transactions (England)
Supersedes in part J. Chem. Soc., A

J. Chem. Soc., Faraday Trans., I
Journal of the Chemical Society (London), Faraday
Transactions, I (England)
Supersedes in part J. Chem. Soc., A and Trans. Faraday Soc.

J. Chem. Soc., Faraday Trans., II
Journal of the Chemical Society (London), Faraday
Transactions, II (England)
Supersedes in part J. Chem. Soc., A and Trans. Faraday Soc.

J. Chem. Soc., Perkin Trans., II
Journal of the Chemical Society (London), Perkin
Transactions, II (England)
Supersedes J. Chem. Soc., B

J. Chromatogr. Sci.
Journal of Chromatographic Science (U.S.)
Supersedes Journal of Gas Chromatography

J. Conn. State Dent. Ass.
Journal of the Connecticut State Dental Association (U.S.)

J. Coord. Chem.
Journal of Coordination Chemistry (England)

J. Eur. Toxicol.
Journal Europeen de Toxicologie (France)

J. Fla. Med. Ass.
Journal of the Florida Medical Association (U.S.)

J. Ga. Entomol. Soc.
Journal of the Georgia Entomological Society (U.S.)

J. Geol. Soc. India
Journal of the Geological Society of India (India)

Jinruigaku Zasshi
Jinruigaku Zasshi (The Journal of the Anthropological Society of Japan) (Japan)

J. Jap. Soc. Appl. Phys., Suppl.
Journal of the Japan Society of Applied Physics, Supplement (Japan)

J. Korean Inst. Elec. Eng.
Journal of the Korean Institute of Electrical Engineers, The (Daehan Jeonkihakhoe-ji) (South Korea)

J. Korean Inst. Electron. Eng.
Journal of the Korean Institute of Electronics Engineers, The (Jeonja-gonghakhoe-ji) (South Korea)

J. Microscopy
Journal of Microscopy (England)
Supersedes J. Roy. Microscop. Soc.

Joekull (Reykjavik)
Joekull (Reykjavik) (Iceland)

J. Ont. Dent. Ass.
Journal of the Ontario Dental Association, The (Canada)

J. Paint Technol.
Journal of Paint Technology (U.S.)

J. Periodontal Res.
Journal of Periodontal Research (Denmark)

J. Soc. Dyers Colour.
Journal of the Society of Dyers and Colourists (England)

K

Kagaku Keizai
Kagaku Keizai (Chemical Industrial Economy) (Japan)

KFK Nachr.
KFK (Kernforschungszentrum Karlsruhe) Nachrichten (West Germany)

Kibern. Vychisl. Tekh.
Kibernetika i Vychislitel'naya Tekhnika (Ukrainian S.S.R.)

Kim. Sanayi
Kimya ve Sanayi (Turkey)

Koku Igaku Jikkentai Hokoku
Koku Igaku Jikkentai Hokoku (The Reports of the Aero Medical Lab.) (Japan)

Konstr. Ing. Ber.
Konstruktiver Ingenieurbau Berichte (West Germany)

Konstr. Mater. Osn. Grafita
Konstruktsionnye Materialy na Osnove Grafita (U.S.S.R.)

Korean Biochem. J.
Korean Biochemical Journal, The (Hankuk Saenghwahakhoe-ji) (South Korea)

Korean J. Hort. Sci.
Korean Journal of Horticultural Science (Hankuk Wonyehakhow-ji) (South Korea)

Koryo
Koryo (Aromatics) (Japan)

Kotsu Igaku
Kotsu Igaku (The Journal of Transportation Medicine) (Japan)

Kuki Chowa To Reito
Kuki Chowa To Reito (Air Conditioning and Refrigeration) (Japan)

Kvantovaya Elektron.
Kvantovaya Elektronika (Ukrainian S.S.R.)

L

Lesovedenie
Lesovedenie (U.S.S.R.)

Log Anal.
Log Analyst (U.S.)

M

Magy. Asvanyolaj Foldgaz Kiserl. Intez. Kiadv.
Magyar Asvanyolaj es Foldgaz Kiserleti Intezet Kiadvanyai (Hungary)

Magy. Textiltech.
Magyar Textiltechnika (Hungary)

Maintenance
Maintenance (France)

Mannesmann Forschungsber.
Mannesmann Forschungsberichte (West Germany)

Mashinostroene
Mashinostroene (Bulgaria)

Med. Lab. Technol.
Medical Laboratory Technology (England)
Supersedes J. Med. Lab. Technol.

Med. Microbiol. Immunol.
Medical Microbiology and Immunology (West Germany)
Supersedes Z. Med. Mikrobiol. Immunol.

Mem. Real Acad. Cienc. Artes Barcelona
Memorias de la Real Academia de Ciencias y Artes de Barcelona (Spain)

Metallges., Rev. Activ.
Metallgesellschaft, Review of the Activities (West Germany)
German Edition issued as Metallges., Mitt. Arbeitsbereich

Metallofizika
Metallofizika (Ukrainian S.S.R.)

Metall-Reinig. Vorbehandl.
Metall-Reinigung und Vorbehandlung (West Germany)

Metallurgie (Mons, Belg.)
Metallurgie (Mons, Belgium) (Belgium)

Metalwork. Econ.
Metalworking Economics (U.S.)

Methods Biochem. Anal.
Methods of Biochemical Analysis (U.S.)

Mich. Med.
Michigan Medicine (U.S.)

Miner. Sci. Eng.
Minerals Science and Engineering (South Africa)

Minneapolis Dist. Dent. J.
Minneapolis District Dental Journal, The (U.S.)

Mitsubishi Seiko Giho
Mitsubishi Seiko Giho (Japan)

Mitt. Astron. Ges.
Mitteilungen der Astronomischen Gesellschaft (West Germany)

Modif. Polim. Mater.
Modifikatsiya Polimernykh Materialov (Latvian S.S.R.)

Moessbauer Eff. Methodol., Proc. Symp.
Moessbauer Effect Methodology, Proceedings of a
Symposium (U.S.)

Morsk. Gidrofiz. Issled.
Morskie Gidrofizicheskie Issledovaniya (U.S.S.R.)

Munca Sanit.
Munca Sanitara (Romania)

N

Nagoya Daigaku Kankyo Igaku Kenkyusho Nempo
Nagoya Daigaku Kankyo Igaku Kenkyusho Nempo (Japan)
English Edition issued as Annu. Rep. Res. Inst. Environ.
Med., Nagoya Univ.

Nagoya-Shi Kogyo Kenkyusho Kenkyu Hokoku
Nagoya-Shi Kogyo Kenkyusho Kenkyu Hokoku (Research Reports
for the Nagoya Municipal Industrial Research Institute)
(Japan)

Nat. Bur. Stand. (U.S.), Spec. Publ.
National Bureau of Standards (U.S.), Special
Publication (U.S.)

Natura (Plovdiv)
Natura (Plovdiv) (Bulgaria)

Nauch. Tr. Mosk. Inzh.-Ekon. Inst.
Nauchnye Trudy Moskovskogo Inzhenerno-Ekonomicheskogo
Instituta (U.S.S.R.)

Nippon Hifuka Gakkai Zasshi
Nippon Hifuka Gakkai Zasshi (Journal of the Japanese
Dermatological Association) (Japan)

Nogyo Gijutsu Kenkyusho Hokoku, B
Nogyo Gijutsu Kenkyusho Hokoku, B. Dojo Hiryo
(Bulletin of the National Institute of Agricultural Science,
Series B, Soils and Fertilizers) (Japan)

Nord. Hydrol.
Nordic Hydrology (Denmark)

Norsk Vet.-Tidsskr.
Norsk Veterinaer-Tidsskrift (Norway)

Nouv. Presse Med.
Nouvelle Presse Medicale, La (France)
Supersedes Presse Medicale, La

Novosti Med. Priborostr.
Novosti Meditsinskogo Priborostroeniya (U.S.S.R.)

N. Z. J. Agr. Res.
New Zealand Journal of Agricultural Research (New Zealand)

O

Occup. Health Bull.
Occupational Health Bulletin (Canada)

P

Paraplegia
Paraplegia (Scotland)

Particles Nucl.
Particles and Nuclei (U.S.)

Perspect. Powder Met.
Perspectives in Powder Metallurgy (U.S. - England)

Pharm. Ztg.
Pharmazeutische Zeitung (West Germany)

Polimery
Polimery (Poland)

Poluprov. Tekh. Mikroelektron.
Poluprovodnikovaya Tekhnika i Mikroelektronika
(Ukrainian S.S.R.)

Polyar. Siyaniya
Polyarnye Siyaniya (U.S.S.R.)

Polym. J.
Polymer Journal (Japan)

Polytech. Tijdschr., Elektrotech./Electron.
Polytechnisch Tijdschrift, Elektrotechniek/Elektronica
(Netherlands)

Polytech. Tijdschr., Procestech.
Polytechnisch Tijdschrift, Procestechniek (Netherlands)

Praeventivmedizin
Praeventivmedizin (Switzerland)

Prax. Penumol.
Praxis der Penumolgie (West Germany)

Probl. Fiz. Elem. Chastits At. Yadra
Problemy Fiziki Elementarnykh Chastits i Atomonogo
Yadra (U.S.S.R.)

Pr. Stud. Zakl. Badan Nauk. Gorn. Okregu Przem. Pol. Akad. Nauk
Prace i Studia Zakladu Badan Naukowych Gornoslaskiego Okregu
Przemyslowego Polskiej Akademii Nauk (Poland)

Publ. Tartu. Astrofiz. Observ.
Publikatsii Tartuskoi Astrofizicheskoi Observatorii
(Estonian S.S.R.)

Pulp Pap. Mag. Can.
Pulp and Paper Magazine of Canada (Canada)

Purasuchikkusu
Purasuchikkusu (Japan Plastics) (Japan)

R

Radiat. Data Rep.
Radiation Data and Reports (U.S.)
Supersedes Radiological Health Data and Reports

Radiats. Tekh.
Radiatsionnaya Tekhnika (U.S.S.R.)

Rend. Semin. Fac. Sci. Univ. Cagliari
Rendiconti del Seminario della Facolta di Scienze della
Universita di Cagliari (Italy)

Rend. Soc. Ital. Mineral. Petrologia
Rendiconti della Societa Italiana de Mineralogia e
Petrologia (Italy)

Res. Commun. Chem. Pathol. Pharmacol.
Research Communications in Chemical Pathology and
Pharmacology (U.S.)

Res. Rep. Fish. Comm. Oreg.
  Research Reports of the Fish Commission of Oragon (U.S.)

Rev. A
  Revue A (Institut Belge de Regulation et d'Automatisme, Brussels) (Belgium)

Rev. Anal. Chem.
  Reviews in Analytical Chemistry. International Quarterly Scientific Reviews Journal (Israel)

Rev. Coatings Corros.
  Reviews on Coatings and Corrosion (Israel)

Rev. Coroz.
  Revista de Coroziune (Romania)

Rev. Epidemiol. Med. Soc. Sante Publique
  Revue d'Epidemiologie Mededine Sociale et Sante Publique (France)
  Continues Rev. Hyg. Med. Soc.

Rev. Gaucha Odontol.
  Revista Gaucha de Odontologia (Brazil)

Rev. High-Temp. Mater.
  Reviews on High-Temperature Materials (Israel)

Rev. Soc. Roy. Belge Ing. Ind.
  Revue de la Societe Royale Belge des Ingenieurs et des Industriels (Belgium)

Rinsho Hinyokika
  Rinsho Hinyokika (Japan)

Rinsho Kagaku
  Rinsho Kagaku (Japan)

Rocz. Inst. Przem. Mlecz.
  Roczniki Instytutu Przemyslu Mleczarskiego (Poland)

Russ. Eng. J. (Engl. Transl.)
  Russian Engineering Journal (English Translation of Vestnik Mashinostroeniya) (England)

S

Sanit. Heizungstech.
  Sanitaer - Heizungstechnik (West Germany)

Sanka To Fujinka
  Sanka To Fujinka (Obstetrics and Gynecology, The) (Japan)

Sb. Nauch. Tr., Fiz.-Tekh. Inst. Nizk. Temp., Akad. Nauk Ukr. SSR
  Sbornik Nauchnykh Trudov, Fiziko-Tekhnicheskii Institut Nizhikh Temperatur, Akademiya Nauk Ukrainskoi SSR (Ukrainian S.S.R.)

Sb. Tr. Klyuchevsk. Zavoda Ferrosplavov
  Sbornik Trudov Klyuchevskogo Zavoda Ferrosplavov (U.S.S.R.)

Schiff Hafen
  Schiff und Hafen (West Germany)

Schweisstechnik (Berlin)
  Schweisstechnik (Berlin) (East Germany)

Schweiz. Z. Hydrol.
  Schweizerische Zeitschrift fuer Hydrologie (Switzerland)

Sci Publ., Res. Inst. Radiol. Radiat. Hyg.
  Scientific Publications, Research Institute of Radiology and Radiation Hygiene (Bulgaria)

Sediment. Geol.
  Sedimentary Geology (Netherlands)

Seifen-Oele-Fette-Wachse
  Seifen-Oele-Fette-Wachse (West Germany)

Selec. Annu. Rev. Anal. Sci.
  Selected Annual Reviews of the Analytical Sciences (England)

Shigen
  Shigen (Resources) (Japan)

Shikai Tenbo
  Shikai Tenbo (Dental Outlook) (Japan)

Shinryo To Shinyaku
  Shinryo To Shinyaku (Medical Consultation and New Remedies) (Japan)

Shizuoka-Ken Kogyo Shikenjo Hokoku
  Shizuoka-Ken Kogyo Shikenjo Hokoku (Japan)

Shokuhin Kogyo
  Shokuhin Kogyo (Food Industry) (Japan)

Shonika Rinsho
  Shonika Rinsho (Japanese Journal of Pediatrics) (Japan)

Silk Rayon Ind. India
  Silk and Rayon Industries of India (India)

Silva Fenn.
  Silva Fennica (Finland)

Slevarenstvi
  Slevarenstvi (Czechoslovakia)

Solvent Extr. Rev.
  Solvent Extraction Reviews (U.S.)

Sov. Rubber Technol. (Engl. Transl.)
  Soviet Rubber Technolgy (English Translation of Kauchuk i Rezina) (England)

Statens Offentliga Utredn.
  Statens Offentliga Utredningar (Sweden)

Stoma
  Stoma (West Germany)

Stoma (Thessaloniki)
  Stoma (Thessaloniki) (Greece)

Stomatol. Glas. Srb.
  Stomatoloski Glasnik Srbije (Yugoslavia)

Struct. Eng.
  Structural Engineer, The (England)

Stud. Univ. Babes-Bolyai, Ser. Geol.-Mineral.
  Studia Universitatis Babes-Bolyai, Series Geologia-Mineralogia (Romania)

Sumitomo Jukikai Giho
  Sumitomo Jukikai Giho (Japan)

Sv. Kraftverksfoereningens Publ.
  Svenska Kraftverksfoereningens Publikationer (Sweden)

Swed. J. Agr. Res.
  Swedish Journal of Agricultural Research (Sweden)
  Supersedes Lantbrukshogsk. Ann.

Syoni Shikagaku Zasshi
  Syoni Shikagaku Zasshi (Japan)

T

Taehan Saengri Hakhoe Chi
Taehan Saengri Hakhoe Chi (Korean Journal of Physiology) (South Korea)

Taiki Osen Kenkyu
Taiki Osen Kenkyu (Journal of the Japan Society of Air Pollution) (Japan)

Takeda Kenkyusho-Ho
Takeda Kenkyusho-Ho (Journal of the Takeda Research Laboratories) (Japan)

Tenki (Meteorol. Soc. Jap.)
Tenki (Weather (Meteorological Society of Japan)) (Japan)

Tenmon Geppo
Tenmon Geppo (The Astronomical Herald) (Japan)

Tenn. Law Rev.
Tennessee Law Review (U.S.)

Tensai Gijutsu Renraku Kenkyukai Happyo Ronbunshu
Tensai Gijutsu Renraku Kenkyukai Happyo Ronbunshu (Japan)

Tenside
Tenside (West Germany)

TESLA Electron.
TESLA Electronics (Czechoslovakia)

Ti Ch'iu Wu Li Hsueh Pao
Ti Ch'iu Wu Li Hsueh Pao (Journal of Geophysics) (China) Discontinued

Tokushuko
Tokushuko (Special Steel) (Japan)

Toyoda Kenkyu Hokoku
Toyoda Kenkyu Hokoku (Japan)

Toyo Shokuhin Kogyo Tanki Daigaku, Toyo Shokuhin Kenkyusho Kenkyu Hokokusho
Toyo Shokuhin Kogyo Tanki Daigaku, Toyo Shokuhin Kenkyusho Kenkyu Hokokusho (Toyo Junior College of Food Technology and Toyo Institute of Food Technology, Research Report) (Japan)

Trans., Gulf Coast Ass. Geol. Soc.
Transactions, Gulf Coast Association of Geologic Societies (U.S.)

Transp. Theory Statist. Phys.
Transport Theory and Statistical Physics (U.S.)

Tr. Gor'k. Politekh. Inst.
Trudy Gor'kovskogo Politekhnicheskogo Instituta (U.S.S.R.)

Tr. Inst. Mikrobiol. Virusol., Akad. Nauk Kaz. SSR
Trudy Instituta Mikrobiologii i Virusologii Akademiya Nauk Kazakhskoi SSR (Kazakh S.S.R.)

Tr. Inst. Org. Katal. Elektrokhim., Akad. Nauk Kaz. SSR
Trudy Instituta Organicheskogo Kataliza i Elektrokhimii, Akademiya Nauk Kazakhskoi SSR (Kazakh S.S.R.)

Tr. Khim. Khim. Tekhnol.
Trudy po Khimii i Khimicheskoi Tekhnologii (U.S.S.R.)

Tr. Leningrad. Khim.-Farm. Inst.
Trudy Leningradskogo Khimichesko-Farmatsevticheskogo Instituta (U.S.S.R.)

Tr. Nauch.-Issled. Gidrometeorol. Inst. (Alma-Ata)
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